BANISTERIA

A JOURNAL DEVOTED TO THE NATURAL HISTORY OF VIRGINIA

Great White Heron (*Ardea herodias occidentalis*)

This white subspecies of the Great Blue Heron normally inhabits southern Florida and the West Indies, but after tropical storms and hurricanes it may rarely appear in Virginia. This bird was found in Shenandoah County in 2006, as discussed on pages 35-36 of this issue.

Number 30 ISSN 1066-0712 2007

B A N I S T E R I A

A JOURNAL DEVOTED TO THE NATURAL HISTORY OF VIRGINIA

ISSN 1066-0712

Published by the Virginia Natural History Society

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Banisteria No. 29 was published on 25 September 2007.

Cover: Great White Heron (*Ardea herodias occidentalis*), photograph by Rob Simpson.
Back cover: *Nannocoris arenarius* (Heteroptera: Schizopteridae), original drawing by Richard Hoffman.

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Number 30, 2007

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Arctodiaptomus dorsalis (Marsh): A Case History of Copepod Dispersal

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ABSTRACT

The planktonic copepod crustacean *Arctodiaptomus dorsalis* (Marsh) was found in ponds at two warmwater-fish hatcheries in Virginia in the summer of 2006. Because no permanent population is known to exist north of Florida in the eastern United States, the Virginia populations are considered to be introduced. These discoveries provided the impetus for a review of the distribution of this species, based on previously published records, as well as unpublished records derived from museum collections and inquiries of colleagues. This review provided new evidence that the core range of *A. dorsalis* lies in tropical and subtropical lowlands bordering the Gulf of Mexico and Caribbean Sea, from the southern United States through Central America and northern South America, plus the Greater Antilles. There are outlying, published records from Arizona, California, Missouri, Oklahoma, South Carolina, Texas, and Virginia in the United States; the Central Highlands of Mexico; and the Colombian Highlands. Previously unpublished records from Arkansas, Florida, Indiana, Maryland, Michigan, Oklahoma, Texas, Puerto Rico, and Colombia are given herein. Several of the outlying populations were likely established through human agency, via transport of fish or aquatic plants; at least one population, in South Carolina, did not persist. The species has become established in the south-central Mississippi River basin, from Texas as far north as Missouri, and possibly also in Indiana and southern Michigan, primarily in eutrophic impoundments and fish hatcheries although it is not known whether all of the populations previously reported in the region have survived. The population in Indiana has apparently persisted since at least 1980. These observations suggest that *Arctodiaptomus dorsalis* has the potential to extend its range farther north and south, into suitable, eutrophic waterbodies, aided by inadvertent local introductions. Cases of intercontinental introductions of copepods are briefly reviewed.

Key words: Colombia, Copepoda, Crustacea, exotic species. fish hatchery, new records, Puerto Rico, United States.

INTRODUCTION

Questions regarding the geographical distributions, ecological requirements, colonizing capabilities, and dispersal mechanisms of freshwater zooplankton species have engaged limnologists since the early stages of the discipline of freshwater biology. Recently, artificial introductions of freshwater organisms have received much attention, particularly where they affect indigenous aquatic communities, or have the potential to do so. Herein, I briefly review instances of transcontinental introductions of copepod crustaceans. I also provide new information on the distribution of the Neotropical calanoid *Arctodiaptomus dorsalis* (Marsh, 1907), and discuss the possibility that this species is extending its range northward in North America and southward in Colombia, perhaps facilitated by human activities.

Cases of transcontinental introductions of planktonic crustaceans into North American waters include the Afro-Asian-Australian cladoceran *Daphnia lumholtzi* G. O. Sars, 1885 (Havel & Shurin, 2004; Benson et al., 2006); the northern-European cladoceran, the spiny water flea *Bythotrephes longimanus* Leydig, 1860 (first identified as *B. cederstroemii* Schödler, 1877) (Liebig & Benson, 2006); and several copepods, especially in the Laurentian Great Lakes (Hudson & Lesko, 2003).

Reid & Pinto-Coelho (1994) reviewed the 21 cases of intercontinental introductions of freshwater and

estuarine copepods known to that date. Since then, several more cases have been documented, or suggested. Species of Cyclopoida predominate: the Afro-Asian cyclopoid *Mesocyclops ogunnus* Onabamiro, 1957, besides becoming established in reservoirs in central Brazil (Reid & Pinto-Coelho, 1994; Matsumura-Tundisi & Silva, 2002), has appeared in ponds in the Cayman Islands (Suárez-Morales et al., 1999), and recently in a plant tray and a pond in the Florida Keys (Hribar & Reid, 2008). The supposedly Asian *Bryocyclops muscicola* (Menzel, 1926) appeared in several locations in Florida (Reid, 1999; Bruno et al., 2005; Reid & Hribar, 2006; Hribar & Reid, 2008); the Asian *Apocyclops dengizicus* (Lepeshkin, 1900) in Virginia and Maryland (Reid et al., 2002); the European *Megacyclops viridis* (Jurine, 1820), in Lake Superior (Hudson & Lesko, 2003); the Asian *Mesocyclops pehpeiensis* Hu, 1943, in southeast Mexico (Suárez-Morales et al., 2005); and the South American *Paracyclops bromeliacola* Karaytug & Boxshall, 1998, in Florida (Reid & Hribar, 2006).

Species of Calanoida include the North American *Skistodiaptomus pallidus* (Herrick, 1879) and the Asian *Sinodiaptomus valkanovi* Kiefer, 1938, in New Zealand (Duggan et al., 2006). The Australasian calanoid *Boeckella triarticulata* (Thomson, 1883), first found in northern Italy in the 1980s, has recently reappeared there (Ferrari & Rossetti, 2006).

There are relatively few records of harpacticoids. The Ponto-Caspian *Nitokra incerta* (Richard, 1893) has been found near the mouth of the Detroit River in Michigan (Grigorovich et al., 2001). The European *Nitokra hibernica* (Brady, 1880), which was first reported from Lake Ontario in 1978, is now common in all of the Great Lakes except Lake Superior (Hudson & Lesko, 2003). The euryhaline, European *Schizopera borutzkyi* Monchenko, 1967 was first reported from Lake Michigan by Horvath et al. (2001), and has since spread into Lake Erie (Hudson & Lesko, 2003).

Known instances of range expansions of planktonic copepods within the same continent are much fewer. *Skistodiaptomus pallidus*, which was first found in the north-central and plains states (Wilson & Yeatman, 1959), seems to have colonized the eastern states beginning with North Carolina and Virginia sometime after 1940 (Saunders, 1975); its presence west of the Rocky Mountains was first noted in 1970 (Byron & Saunders, 1981). *Eudiaptomus gracilis* (G. O. Sars, 1862), which is common throughout most of Europe, began to appear in lakes in northern Italy in the late 1980s, where it is now displacing the native *Eudiaptomus padanus* (Burckhardt, 1900) (Riccardi & Giussani, 2007). The best-studied case is that of the circumboreal temorid calanoid copepod *Eurytemora affinis* (Poppe, 1880), which formerly occurred only in brackish coastal waters, and has in the past 70 years invaded many inland, fresh waterbodies in North America, Europe, and Asia (Lee, 1999; Benson, 2006). Its Palaearctic congener *E. velox* (Lilljeborg, 1853) has similarly moved from coastal into inland waters in Europe during the past century (Gavíria & Forró, 2000). The estuarine harpacticoid *Heteropsyllus nunni* Coull, 1975, known originally from the coast of South Carolina, has appeared in the Great Lakes (Horvath et al., 2001; Hudson & Lesko, 2003).

The large diaptomid calanoid copepod genus *Arctodiaptomus* is primarily Palaearctic; 6 of its 37 species are known to occur in the Americas. Of these, *Arctodiaptomus dorsalis* (Marsh, 1907) has extended the farthest south, through Central America to northern South America, and is considered to be essentially Neotropical (Suárez-Morales & Reid, 2003; Suárez-Morales et al., 2005). It was originally described by Marsh (1907, as *Diaptomus dorsalis*) from Guzman and Milneburg, two now-extinct towns formerly located near New Orleans, Louisiana. The species was subsequently reported from elsewhere in the southern and southwestern United States; Mexico; several countries in Central America; the Bahamas, Cuba, and Haiti in the Antilles; and northern Colombia and Venezuela in South America. Although *A. dorsalis* is most common in lowlands bordering the Gulf of Mexico and Caribbean Sea, there are many reports of populations outside that region: in the central Mexican and Colombian highlands, and in Arizona, central California, Oklahoma, northern Texas, Maryland, Missouri, and South Carolina in the United States. *Arctodiaptomus dorsalis* has highly distinctive morphological characters, including, in most populations, dorsal projections on the posterior thorax of adult females, from which it derives its name. Its biology has been well studied, particularly in Florida, where it is often dominant in the plankton of eutrophic ponds and lakes across the central and northwestern parts of that state (Bruno et al., 2005, and references therein).

Arctodiaptomus dorsalis usually occurs in perennial ponds, lakes, and impoundments. It can survive in subterranean waters: in addition to many cenotes (sinkhole lakes) in the Yucatan Peninsula (e.g., Suárez-Morales et al., 1996; Suárez-Morales & Reid, 2003), it was found in phreatic groundwater in a cave in Cuba (Bowman, 1979), and in the Split Sink cave system, Florida (Bruno et al., 2005). The only record from a natural, temporary waterbody is from a seasonal floodplain pond in Missouri (Havel et al., 2000). *Arctodiaptomus dorsalis* may be able to overwinter by means of resting eggs. Although I have been unable to

locate a report of resting eggs of this species, its presence in a temporary waterbody suggests that it does have this capability, as do many species of diaptomids, including several congeners (Williams-Howze, 1997). Like most diaptomids, it is a selective phytoplankton grazer; it prefers diatoms but will also ingest cyanobacteria (blue-green algae) and chlorophytes (Cisneros et al., 1991; Ahlgren et al., 2000). It is often dominant in eutrophic waterbodies, such as throughout central Florida. Elmore (1983) suggested that *A. dorsalis* cannot survive under conditions of low food concentrations. This species also dominates the crustacean zooplankton in moderately productive Guatemalan lakes (Deevey et al., 1980). It occurs in waters of a rather wide range of chemistry: Cole (1961, 1966) reported that in one of the Arizona ponds where *A. dorsalis* was found, the chloride content was 950 mg/L, and the standard conductivity was 1,900 µmhos (1.9 $S \cdot m^{-1}$), i.e., in the oligohaline range. The Keystone Reservoir in Oklahoma, which drains semi-arid salt plains, is also rather saline, with measured conductivities of 1,114 to 4,672 µmhos when *A. dorsalis* was collected there in 1967-1968 (Kochsiek et al., 1971). Its rather small size (0.77-1.13 mm for females, 0.78-1.06 mm for males) may allow it to maintain substantial populations under heavy predation pressure from planktivorous fish (Deevey et al., 1980). Like many diaptomids that are planktonic in permanent waterbodies, its body is transparent, another anti-predator adaptation. A more important factor may be that, when food is not limiting, it can produce a large number of small, fast-developing eggs, and its nauplii and copepodids develop quickly compared to other diaptomids, i.e., it is an *r*-strategist (Elmore, 1983).

In waterbodies at higher latitudes and altitudes, *A. dorsalis* may appear mainly in the warmer seasons. In the Atchafalaya River basin floodplain complex, Davidson et al. (1998) found that it was a minor component of the crustacean plankton, and increased in abundance only in late summer. Davidson et al. (1998) further reported that this increase was correlated with higher dissolved oxygen concentrations, maintained by high algal populations, in summer.

Although morphologically distinct, *A. dorsalis* was described by four workers under different names: *Diaptomus dorsalis* (Marsh, 1907), *Diaptomus dampfi* (Brehm, 1932 and 1939; from Lake Petén, Guatemala); *Diaptomus proximus* (Kiefer, 1936; from Haiti); and *Diaptomus alter* (Herbst, 1960; from Lake Managua, Nicaragua). The shared identity of the first three taxa was noted by Wilson & Yeatman (1959) and Cole (1976), and was discussed in detail by Collado et al. (1984) and Dussart & Fernando (1985). Suárez-Morales & Elías-Gutiérrez (2001) were able to obtain specimens from Lake Petén, and confirmed their suspicion that the species there is indeed *A. dorsalis* (as earlier reported by Deevey et al., 1980). As Collado et al. (1984) remarked, the reasons for this confusion include the inevitable differences among specialists in preparation, perception, observation, and illustration of complex structures, and the limited material available to some authors. The reluctance of taxonomists to assign newly discovered, unfamiliar material to a known taxon, slight differences from published descriptions, and occurrences far from the type locality probably also played a part in the proliferation of names.

During a "BioBlitz" 24-hour biological survey held in June 1996 in the Kenilworth Park and Aquatic Gardens in Washington, D.C., I collected a single male of *A. dorsalis* in an outdoor artificial pond. This record was reported in an unreviewed, online checklist of the copepod crustaceans of the District of Columbia (Reid, 1996), but has not been published elsewhere. This species may have been brought in by human agency, possibly along with ornamental water plants. The Asian cyclopoid *Mesocyclops pehpeiensis* Hu, 1943 (reported as *M. ruttneri* Kiefer, 1981, which has since been synonymized with *M. pehpeiensis*), was also present in Kenilworth ponds and greenhouse tanks. Neither species has been found in any other waterbody in the District of Columbia (Reid, 1996; Reid, unpublished data).

Arctodiaptomus dorsalis occurred in plankton samples taken in July 2006 from two fish ponds at the Vic Thomas Striped Bass Hatchery in Brookneal, Campbell County, Virginia. A collection in August 2006 from ponds at the Harrison Lake National Fish Hatchery in Charles City County, Virginia, which supplied fish to the Brookneal facility in 2005 and 2006, also yielded *A. dorsalis* in large numbers. This species was not present in plankton samples from two other warmwater-fish hatcheries in Virginia, the King and Queen Fish Cultural Station at Stevensville in King and Queen County, and the Buller Fish Cultural Station in Smyth County, also in August 2006.

Existing summaries of the distribution of *A. dorsalis* are regional in focus (e.g., Bowman, 1986; Reid, 1990; Suárez-Morales, 1991; Bruno et al., 2005; Suárez-Morales et al., 2005). Therefore, I review published records, add several, previously unpublished records derived from museum holdings, personal collections, and records communicated by colleagues, and provide a detailed map of the resulting known distribution of *A. dorsalis*.

METHODS

Copepods were collected with a small plankton net, transported in plastic bags in an insulated container on ice to the laboratory, sorted, and fixed and preserved in 70% ethanol or isopropanol. The species contained in the samples were identified primarily through the keys by Reed (1994) and Wilson & Yeatman (1959), with recourse to more recent literature when necessary. The specimens from D.C. are deposited in the collection of the Department of Invertebrate Zoology, National Museum of Natural History, Smithsonian Institution (USNM). The specimens from Arkansas, Indiana, and Virginia are deposited in the collection of the Department of Recent Invertebrates, Virginia Museum of Natural History (VMNH), and the Crustacea Catalogue Database numbers are provided.

Material examined:

Arkansas: 10 females and 10 males, fish culture ponds at the University of Arkansas Pine Bluff Aquaculture/ Fisheries Center, Lonoke, Lonoke County (Site 15 in Fig. 1, Site 18 in Fig. 2), June 13, 2007, leg. S. Kumaran, det. J. W. Reid (VMNH 1478).

District of Columbia: 1 male, Kenilworth Park and Aquatic Gardens (Site 1 in Fig. 1, Site 13 in Fig. 2), lily display pond, 4 October 1996, leg. S. W. Syphax and J. W. Reid, det. J. W. Reid (USNM 278173).

Indiana: 20 females, 20 males, and 20 copepodids, Cikana State Fish Hatchery (Site 12 in Fig. 1, Site 10 in Fig. 2), Martinsville, Morgan County, sample combined from several ponds, 5 September 2006, leg. D. Jessup, det. J. W. Reid (VMNH 1316).

Virginia: 2 females and 2 copepodids, Pond 1, Vic Thomas Striped Bass Hatchery (Site 2 in Fig. 1, Site 16 in Fig. 2), Brookneal, Campbell County, 24 July 2006, leg. det. J. W. Reid (VMNH 1263). 10 females, 10 males, and 100 copepodids, Pond 4, Vic Thomas Striped Bass Hatchery, Brookneal, Campbell County, 24 July 2006, leg. det. J. W. Reid (VMNH 1264). 20 females and 20 males, combined from Ponds B1, B2, C1, E1, E2, E3, E4, E5, F1, F2, C2, and C3, all fresh water, Harrison Lake National Fish Hatchery (Site 3 in Fig. 1, Site 15 in Fig. 2), Charles City County, 3 August 2006, leg. det. J. W. Reid (VMNH 1276). 20 females and 20 males, Pond F5, salinity 1.5 ‰, temperature 35 °C, Harrison Lake National Fish Hatchery, Charles City County, 3 August 2006, leg. det. J. W. Reid (VMNH 1277).

Colombia: 5 males, 55-gallon drums, Hacienda Fircal, Vereda La Esperanza, Mesa de los Santos, Municipio Puedecuesta, Santander, leg. M. F. Suárez and O. Vargas, det. J. W. Reid (specimens temporarily at USNM; to be transferred to VMNH; Site 8 in Fig. 1). This record was briefly noted as "Colombia" by Reed (1994).

Puerto Rico: 2 females and 1 copepodid, Canal de Sague, Langostiños del Caribe, Sabana Grande (Site 7 in Fig. 1), 14 June 1990, leg. C. Aranda and M. Rivera, det. J. W. Reid (USNM 284703). 13 females and 10 males, Ponds 164, 166, and 173, Langostiños del Caribe, Sabana Grande, 16 August 1990, leg. M. F. Suárez and C. Aranda, det. J. W. Reid (USNM 284704). These records were briefly noted as "Puerto Rico" by Reid (1990).

The published reports used to compile the distribution map in Figure 1, listed by country and department, province, or state, are as follows:

United States: California (Suárez-Morales & Elías-Gutiérrez, 2001), Florida (Marsh, 1929; Suárez-Morales & Elías-Gutiérrez, 2001; Bruno et al., 2005, and references therein; Reid & Hribar, 2006), Louisiana (Marsh, 1907, 1929; Davidson, 1996; Davidson et al., 1998, 2000; Suárez-Morales & Elías-Gutiérrez, 2001), Mississippi (Harris, 1978), Missouri (Havel et al., 2000), Oklahoma (Robertson, 1970, 1972; Kochsiek et al., 1971), South Carolina (Taylor et al., 1993), Texas (Smith et al., 1978, 1979).

Mexico: Aguascalientes (Dodson & Silva-Briano, 1996; Silva-Briano & Suárez-Morales, 1998), Campeche (Suárez-Morales, 2003), Morelos (Álvarez-Silva & Gómez-Aguirre, 2000b; Álvarez-Silva & Campos-Verduzco, 2001; Suárez-Morales & Elías-Gutiérrez, 2001; Gómez-Marquez et al., 2003), Quintana Roo (Suárez-Morales & Rivera-Arriaga, 2000; Suárez-Morales & Elías-Gutiérrez, 2001; Suárez-Morales, 2003), Tabasco (Álvarez-Silva & Gómez-Aguirre, 2000b; Álvarez-Silva & Campos-Verduzco, 2001; Gutiérrez-Aguirre & Suárez-Morales, 2001; Suárez-Morales & Elías-Gutiérrez, 2001; Álvarez-Silva et al., 2002), Veracruz (Torres-Orozco & Zanatta, 1998; Álvarez-Silva, 1999; Álvarez-Silva & Gómez-Aguirre, 2000a), Yucatán (Suárez-Morales et al., 1996; Suárez-Morales, 2003).

Guatemala: Petén (Brehm, 1932, 1939; Deevey et al., 1980; Suárez-Morales & Elías-Gutiérrez, 2001), Izabal (Brinson & Nordlie, 1975).

Nicaragua: Lake Nicaragua (Cole, 1976; = Lake Cocibolca, Ahlgren et al., 2000), Lake Xolotlán (= Lake Managua, Herbst, 1960; Cisneros & Mangas, 1991; Cisneros et al., 1991).

Costa Rica: San José (Collado et al., 1984; Dussart & Fernando, 1985; Schaper, 1999); Alajuela, Cartago, and Guanacaste (Collado et al., 1984; Dussart & Fernando, 1985).

Colombia: Antioquia (Ramírez & Díaz, 1997; Buitrago, 1998; Estrada-Posada, 1999, 2006; Jaramillo & Gavíria, 2003; Gallo-Sánchez et al., 2004).

Venezuela: Aragua (González, 1968).

Bahamas: New Providence (Segers et al., 1995).

Cuba: All provinces (Smith & Fernando, 1978); Sancti Spíritus Province (Bowman, 1979, as Las Villas Province; Suárez-Morales & Elías-Gutiérrez, 2001).

Haiti: Laguna Rincón (Kiefer, 1936).

In their review of freshwater copepods from northwestern North America, Chengalath & Shih (1994) listed *A. dorsalis* from Alaska and British Columbia, without further details. Neither A. Robertson (in litt., 2006) nor I have been able to trace the source of these listings, and they appear doubtful, given the confirmed range of the species. Therefore, they are not included in Fig. 1.

Unpublished records of *A. dorsalis* from collections in the Virginia Museum of Natural History and the National Museum of Natural History, personal, unpublished determinations, and unpublished records provided by G. Carter, S. Dodson, S. Gavíria-Melo, P. L. Hudson, A. Robertson, and B. Torke are presented in Figs. 1 and 2. These records are as follows:

United States: Oklahoma: Cleveland County, unnamed, 0.1 acre (0.04 ha) pond, collected in June 1975 by J. P. Magovern, and identified by the late T. E. Bowman (USNM 190874; Site 4 in Figs. 1 and 2).

Communicated by A. Robertson (personal collection): Texas: Steedman Marsh in Hagerman National Wildlife Refuge, Grayson County, 28 August 1970 (Site 6 in Figs. 1 and 2). Arkansas: Old River Lake in Pulaski County, collected on August 22, 1971 (Site 5 in Fig. 1, Site 7 in Fig. 2). Florida: (1) drainage canal along US 27 on the Dade/Broward County line, 16 August 1965; (2) along US 27 in Broward County, 16 August 1965; (3) north of Lake Ida, Delray Beach, Palm Beach County, 17 August 1965; (4) pond in Sarasota, Sarasota County, 31 July 1967; (5) pond along Route 4 near Venice, Sarasota County, 31 July 1967; (6) pond on Longboat Key, Sarasota County, 31 July 1967; (7) flooded area about 3 miles (4.8 km) south of Tarpon Spring, Pinellas County, 20 March 1970; and (8) small lake near Dunedin, Pinellas County, 30 October 1976. (The Florida records are indicated individually by triangles in Fig. 2, but are not numbered.)

Communicated by S. I. Dodson (personal collection): Indiana: Cikana State Fish Hatchery, Martinsville, Morgan County, 39.4449 N, 86.3810 W, 2 June 2005, leg. B. Torke (Site 12 in Fig. 1, Site 10 in Fig. 2). Oklahoma: Fort Gibson Reservoir, Cherokee County, 35.94 N, 95.22 W, 15 July 1995, leg. J. Havel (Site 13 in Fig. 1, Site 12 in Fig. 2).

Communicated by P. L. Hudson and G. Carter (personal observations): Michigan: Edwin S. George Reserve, Livingston County, experimental tanks containing fish and zooplankton, 2006 (Site 14 in Fig. 1, Site 17 in Fig. 2).

Colombia: From S. Gavíria-Melo (personal observations): Antioquia: La Fé Reservoir, Medellín, 1999, 2001; Lago Botanical Garden in Medellín and Porce II Reservoir, 2001 (Site 9 in Fig. 1); Chocó, Ciénaga de Bojayá, lower Atrato River, 6° 32' N, 76° 56' W, 1992 (Site 10 in Fig. 1); Cauca: Salvajina Reservoir, 2° 45' N, 76° 50' W, 1991 (Site 11 in Fig. 1).

RESULTS

All but one of the ponds examined at the Harrison Lake National Fish Hatchery in August 2006 contained populations of adults and juveniles of *A. dorsalis*. Many of the adult females were carrying egg sacs. Another species of diaptomid, *Skistodiaptomus pallidus* (Herrick, 1879), was also present, in smaller numbers, in several of the ponds. *Skistodiaptomus pallidus*, but not *A. dorsalis*, occurred in Harrison Lake itself, which supplies water to the hatchery ponds. Both of the ponds examined at the Vic Thomas Striped Bass Hatchery contained *A. dorsalis*, but no other calanoid species. No individuals of *A. dorsalis* appeared in collections made at the King and Queen or Buller facilities, or in nearby impoundments surveyed in August 2006.

The records of *A. dorsalis* indicate a somewhat disjunct distribution (Fig. 1). Most records are from lowland areas in a region extending from the southern United States around the Gulf of Mexico and the Caribbean to northern South America, plus the Greater Antilles. Other concentrations of records appear at higher latitudes in Texas, Oklahoma, Arkansas, and Missouri. *Arctodiaptomus dorsalis* has been recorded

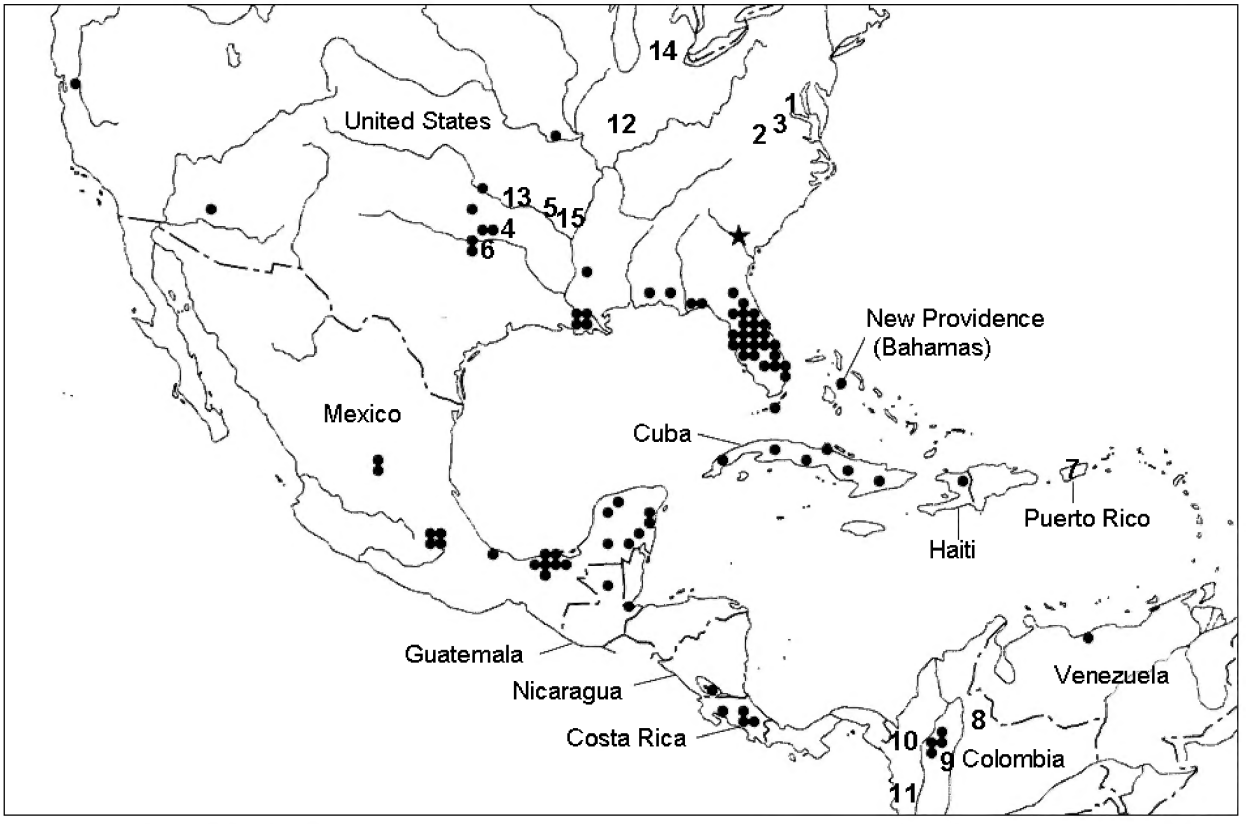

Fig. 1. The known distribution of *Arctodiaptomus dorsalis*. Circles represent published records; most indicate individual records, although where several local waterbodies were investigated, a single circle represents this group. The star indicates an apparently introduced population (in South Carolina) that did not persist. Numbers represent previously unpublished records (see text for locations).

from higher elevations in the states of Aguascalientes and Morelos, Mexico; and the province of Antioquia in Colombia. The population studied by Jaramillo-L. & Gavíria (2003) in Lago Santander, Rionegro, at an elevation of 2100 m in Antioquia, is the highest on record. There are disjunct records from Arizona, California, Indiana, Maryland, Michigan, South Carolina, and Virginia in the United States; and from Cauca Province in Colombia.

DISCUSSION

In certain lowland areas around the Caribbean Sea and Gulf of Mexico, *Arctodiaptomus dorsalis* is extremely common (Fig. 1). In their review of records of copepods in Florida, Bruno et al. (2005) listed this species from 37 named lakes and ponds, as well as several other waterbodies in 23 counties; Reid & Hribar (2006) and Hribar & Reid (2008) reported records from the Florida Keys; and the new records by Robertson given herein add nine additional localities. In Louisiana, Davidson (1996) and Davidson et al. (1998, 2000) found the species in 11 of 30 sites prospected in the lower Atchafalaya River basin. *Arctodiaptomus dorsalis* is also common in the cenotes (subterranean sinkhole lakes) of the Yucatán Peninsula, where it can be very abundant (Suárez-Morales et al., 1996; Suárez-Morales & Rivera-Arriaga, 2000). Deevey et al. (1980) reported it as dominant in the plankton of all ten lakes that they surveyed in the Petén lake district of Guatemala.

Outside this lowland region, reports of *A. dorsalis* are sparser and more widely separated. For instance, in more than 250 samples of calanoids in the mountainous state of Aguascalientes, Mexico, collected over a period of several years, Silva-Briano & Suárez-Morales (1998) reported this species from only two localities. In a general survey covering the drainage basins of six tributaries of the Mississippi River in northern Mississippi, Harris (1978) found *A. dorsalis* only in "a large creek with little or no current" in the Yazoo River drainage, where it was abundant in late summer. In a

recent study of floodplain waterbodies along the Little Tallahatchie River in the same general area, Frisch et al. (2005) did not record this species. Havel et al. (2000) reported *A. dorsalis* from a temporary pond, one of 30 sites that they examined in the floodplain of the Missouri River in Missouri. None of the few other regional surveys of planktonic copepods carried out in recent decades in the central and southeastern United States has reported *A. dorsalis*: North Carolina (Clamp et al., 1999), Wisconsin (Torke, 2001), the Great Lakes region (Hudson & Lesko, 2003). Samples of plankton taken in 38 large and small lakes, ponds, and reservoirs in 24 counties in Virginia from 2002 through 2006 have not contained this species (J. W. Reid, unpubl. data).

Most of the records of *A. dorsalis* in South America are from impoundments and are quite recent, particularly in Colombia. Gavíria (1989, 1994) included no records of *A. dorsalis* in his checklists of copepods from Colombia. Since 1994, *A. dorsalis* has been found in several reservoirs and lakes around Medellín in Antioquia Province (Ramírez & Díaz, 1997; Buitrago, 1998; Estrada-Posada, 1999, 2006; Jaramillo & Gavíria, 2003; Gallo-Sánchez et al., 2004). S. Gavíria-Melo (in litt., August 2006) has collected this species in the Salvajina Reservoir in Cauca Province, at 2° 45' N, the southernmost record in South America. The known distribution in Colombia now includes Antioquia, Cauca, and Chocó provinces (locality data herein; Gavíria & Aranguren, 2007). S. Gavíria-Melo (in litt., August 2006) is of the opinion that *A. dorsalis* is presently expanding southward in Colombia.

The single record from Venezuela (González, 1958) is from an artificial lake in the botanical garden of the Universidad Central in Caracas. Dussart (1984) failed to find this species in collections in northern Venezuela made at 38 localities and in habitats ranging from major lakes and reservoirs to rivers, swamps, bogs, etc.

The record provided by Gavíria-Melo from the Ciénaga de Bojayá in Cauca Province, northern Colombia, fits the pattern of circum-Caribbean, natural, lowland waterbodies that seems to represent the core range of *A. dorsalis*. This may, therefore, represent a natural population.

The sequence and pattern of collections in the central and eastern United States (Fig. 2) suggest that *A. dorsalis* has extended its range into this region in recent decades, and also that this expansion was aided, at least partly, by inadvertent transport along with fish. In the first general survey of diaptomid copepods in Oklahoma, Kingsbury (1966) did not report this species from any of the 92 lakes and ponds examined. In his subsequent, extensive survey and comprehensive listing of diaptomids in Oklahoma, Robertson (1970) recorded *A. dorsalis* from only two localities: a pond at the Durant Fish Hatchery in Bryan County, collected in May 1967; and the Fisheries Research Lab at Noble in Cleveland County, collected in May 1969. Nearly all of the subsequent records from this region are from artificial ponds and reservoirs, many of which are likely to have been stocked with fish; or from fish-culture ponds, i.e., most recently at the University of Arkansas Pine Bluff Aquaculture/Fisheries Center in Lonoke. There is no information as to whether the small pond in Cleveland County, Oklahoma, was natural or artificial (new record herein). The recent record by Havel et al. (2000) from a natural floodplain pond may indicate that *A. dorsalis* can establish populations in relatively unimpacted waterbodies.

The population of *A. dorsalis* in L Lake, a nuclear-reactor cooling reservoir constructed in 1984-1985 on the United States Department of Energy Savannah River Site in South Carolina, may have been introduced along with fish, and eventually disappeared (Taylor et al., 1993). L Lake was stocked with bluegill, *Lepomis macrochirus* Rafinesque, 1819, and largemouth bass, *Micropterus salmoides* Lacépède, 1802, in 1986-1987. Both *Skistodiaptomus pallidus* (Herrick, 1879) and *A. dorsalis* were abundant during the warm months of 1986 and 1987, at the cooler end of the reservoir (water temperature 24-32 °C). An accidental introduction in 1987 and consequent population explosion of threadfin shad, *Dorosoma petenense* (Günther, 1867), was followed by an abrupt decline in all crustacean zooplankton by the next summer. The reactor ceased operation at the end of 1988. Thereafter, *Eurytemora affinis* replaced the diaptomids. Taylor et al. (1993) attributed this shift to predation pressure from threadfin shad, rather than to alterations in the reservoir's temperature regime, because the reactor continued to warm the water periodically during 1988. *Arctodiaptomus dorsalis* has not been seen in L Lake or any other waterbody on the Savannah River Site since 1989 (A. DeBiase, in litt., August 2006), and was not included in a recent checklist (DeBiase & Taylor, 2005).

The pattern and nature of the habitats of other disjunct records are also suggestive of introductions. In his survey of the diaptomids of Arizona, Cole (1961) recorded *A. dorsalis* only from four small, permanent ponds (Papago Ponds) in the Tempe-Scottsdale-Phoenix region. Both Cole (1961, 1966) and Robertson (1972) assumed that these were naturally occurring populations. However, because these waterbodies were artificial and had been used as experimental ponds for rearing fish (Cole, 1966), and, furthermore, because *A. dorsalis* has not been reported again from Arizona, this occurrence may well have been an introduction.

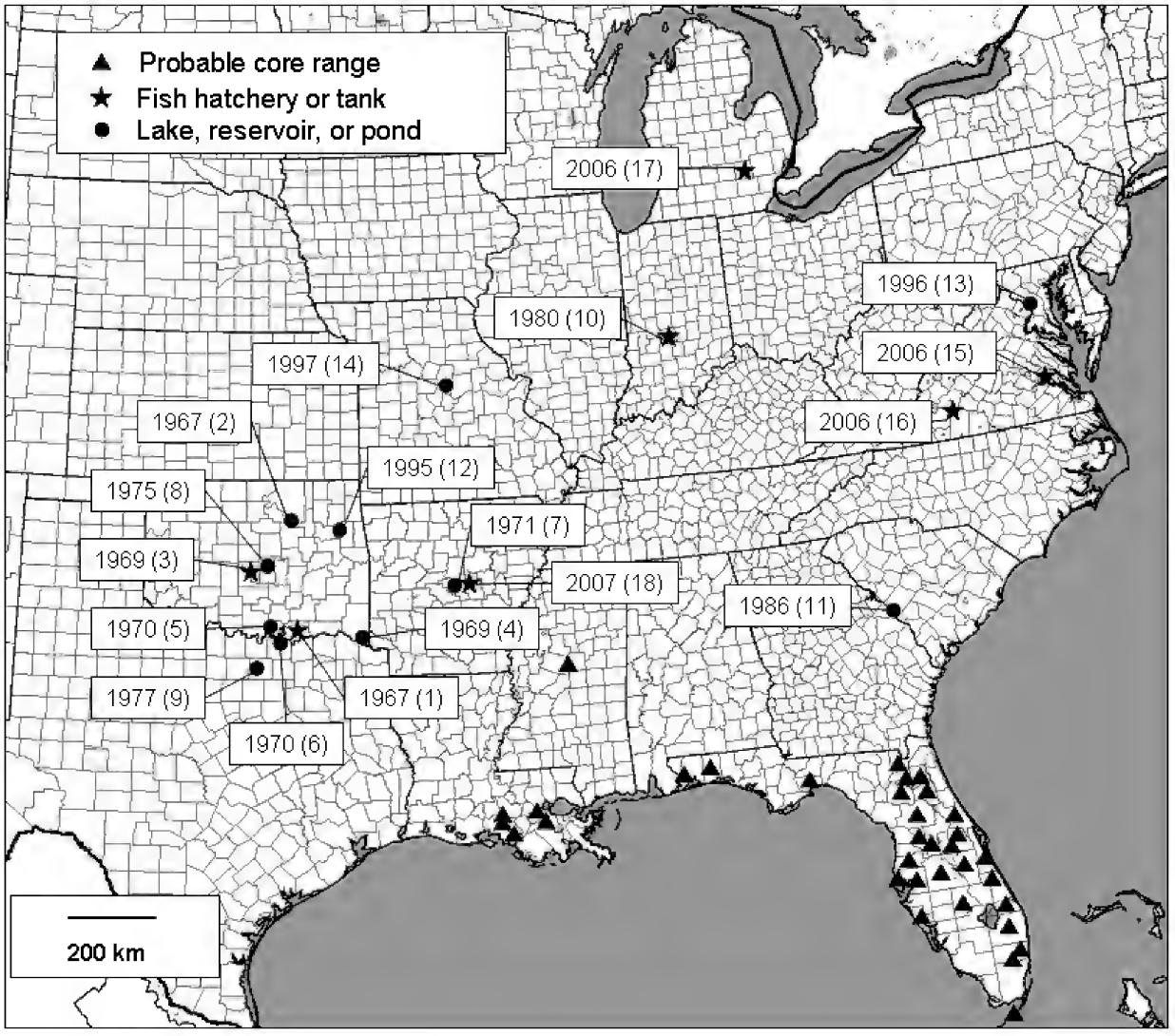

Fig. 2. Localities in the central and eastern United States where *Arctodiaptomus dorsalis* has been recorded. For localities outside its supposed core range, the year when *A. dorsalis* was first recorded is given, followed by the number of the locality in parentheses. 1 – Pond at Durant Fish Hatchery, Bryan County, Oklahoma (Robertson, 1970); 2 – Keystone Reservoir, Pawnee County, Oklahoma (Kochsiek et al., 1971); 3 – Fisheries Research Lab, Noble, Cleveland County, Oklahoma (Robertson, 1970); 4 – Unnamed pond, Cleveland County, Oklahoma (record given herein); 5 – Lake Texoma and pond on largest of group of islands in Lake Texoma, Marshall County, Oklahoma (Robertson, 1972); 6 – Steedman Marsh, Hagerman National Wildlife Refuge, Grayson County, Texas (record given herein); 7 – Old River Lake, Pulaski County, Arkansas (record given herein); 8 – Breedlove Lake, McCurtain County, Oklahoma (Robertson, 1972); 9 – Golf course pond, North Texas State University, Denton, Texas (Smith, 1977; Smith et al., 1978, 1979); 10 – Cikana State Fish Hatchery, Martinsville, Morgan County, Indiana (records given herein); 11 – L Lake, United States Department of Energy Savannah River Site, South Carolina (Taylor et al., 1993); 12 – Fort Gibson Reservoir, Cherokee County, Oklahoma (record given herein); 13 – Artificial pond, Kenilworth Aquatic Gardens, Washington, D.C. (Reid, 1996); 14 – Temporary floodplain pond near the Missouri River in Missouri (Havel et al., 2000); 15 – Ponds, Harrison Lake National Fish Hatchery, Charles City County, Virginia (record given herein); 16 – Ponds, Vic Thomas Striped Bass Hatchery, Brookneal, Campbell County, Virginia (record given herein); 17 – Experimental tanks, Edwin S. George Reserve, Livingston County, Michigan (record given herein); 18 – Fish culture ponds, University of Arkansas Pine Bluff Aquaculture/Fisheries Center, Lonoke, Lonoke County, Arkansas. Localities presumed to be part of the core range of *A. dorsalis* (indicated by solid triangles) are those given by Marsh (1907, 1929), Harris (1978), Davidson (1996), Davidson et al. (1998, 2000), Bruno et al. (2005), Reid & Hribar (2006), and Hribar & Reid (2008).

The occurrence at the Kenilworth Aquatic Gardens in the District of Columbia is also probably an introduction. The diaptomids may have traveled along with ornamental aquatic plants.

The occurrences in Virginia also seem to be introductions. The Harrison Lake facility supplied fish to the Vic Thomas Striped Bass Hatchery and to the King and Queen Fish Cultural Station in 2005 and 2006, but to no other hatcheries (M. Odom, in litt., August 2006). The source of the population at the Vic Thomas facility was most likely the Harrison Lake hatchery. *Arctodiaptomus dorsalis* has not appeared in collections from 38 other lakes and ponds in the Virginia mountains, Piedmont, and Coastal Plain made from 2001 through 2006 (Reid, unpublished data).

The population at the Cikana State Fish Hatchery in Indiana may have been introduced prior to 1980, when a study by T. Schwartz (unpublished Indiana Department of Natural Resources Technical Paper, communicated by D. Jessup) reported it as a major dietary component of larval walleye, *Sander vitreus* (Mitchill, 1818). B. Torke collected *A. dorsalis* at the hatchery in 2005, and it was still present in September 2006. The Cikana hatchery is a warmwater-coolwater facility producing walleye, sauger, channel catfish, fathead minnows, and smallmouth bass. The ponds are earthen and filled by deep wells on the property. The only sources of fish for this hatchery outside Indiana are the Jake Wolf Memorial Fish Hatchery in Illinois, and hatcheries in Illinois and Ohio (D. Jessup, in litt., August 2006). Therefore, there is no direct link to Florida or any other obvious source of this population; one can speculate that it was seeded along with fish.

The record from tanks at the Edwin S. George Reserve in southern Michigan is now the northernmost in the central United States. In 2006, these tanks were stocked with zooplankton, bluegill, and *Chaoborus* sp. from nearby lakes. In the 1980s, redear sunfish *Lepomis microlophus* (Günther, 1859) were stocked in another local lake; the source of the sunfish was likely one or more hatcheries in Indiana or Michigan (G. Carter, in litt., January 2007). Redear sunfish have been widely stocked in southern Michigan since the 1950s, and have established reproducing populations in many waterbodies (Towns, 2003). It is therefore conceivable that populations of *A. dorsalis* may have been seeded along with the fish. Intensive surveys in ponds and lakes in the Great Lakes region (Hudson & Lesko, 2003) and in Wisconsin (Torke, 2001) have not recorded *A. dorsalis*.

The case of the Sacramento River in California is even less clear. According to J. Orsi (in litt., August 2006), over the course of the long-term plankton-sampling program in the Sacramento-San Joaquin Delta conducted by the California Department of Fish and Game, diaptomid copepods were only identified to species level in 1972-75 and again in 1984, at which time voucher specimens were deposited in the NMNH. *Arctodiaptomus dorsalis* was at most a very minor component of the crustacean zooplankton, because it was not among the four diaptomid species listed by Orsi & Mecum (1986). In the 1980s, the diaptomid populations declined sharply, possibly because of competition from introduced Asian calanoids *Sinocalanus doerrii* (Brehm, 1909) and *Pseudodiaptomus forbesi* (Poppe & Richard, 1890). In the late 19th Century, railroad tank cars were filled with water and striped bass *Morone saxatilis* (Walbaum, 1792) from a New Jersey river and shipped to California; this may have been the route of introduction of *Eurytemora affinis* to the Delta (Orsi, 2000, and in litt., August 2006). The eastern species *Skistodiaptomus pallidus* was also found in the Sacramento-San Joaquin estuary in 1973 (Byron & Saunders, 1981).

It has been widely assumed that human-induced alterations of the landscape have created opportunities for many species to expand their ranges. Saunders (1975) noted the large number of eutrophic impoundments in Virginia, which were apparently easily colonized by *S. pallidus*. Byron & Saunders (1981) noted that eutrophication of a marina embayment in Lake Tahoe may have allowed *S. pallidus* to survive in that small part of the lake. Lee & Bell (1999) suggested that the proximate causes of the continental invasions by *Eurytemora affinis* and *E. velox* were the impoundment of brackish waters, turning them fresh; the construction of reservoirs, multiplying the number of lentic habitats; and human-mediated dispersal through shipping traffic (ballast), fish transport, or intentional introduction.

Transport along with stocked fish has been implicated in several cases of introduced copepod populations. One such possible case was reported by Ishida & Ohtaka (2006), who found *E. affinis* in the Tsugaru-Juniko lake complex in Japan, where it was not recorded prior to the 1950s; *E. affinis* is now widespread in the larger lakes containing fish. Similarly, the Australasian-South American *Boeckella triarticulata* was first recorded in Italy in fish ponds in the 1980s, and subsequently disappeared. It was recently reported in the Po River by Ferrari & Rossetti (2006), who proposed the stocking of allochthonous fishes or importation with crop seeds as the most likely vectors.

Arctodiaptomus dorsalis is a native American freshwater species. It has not previously been considered as invasive, and relatively few records have

previously been considered to represent introductions. However, in spite of the obvious gaps in time and space, and the inability to document the exact routes and sources of its movements, the data presented here indicate that *A. dorsalis* is expanding its range. Chapman & Carlton (1991) proposed six criteria to aid in assessing whether a species is introduced on the "provincial scale," i.e., within the same biogeographic realm. The geographical and habitat distribution of *A. dorsalis* in the areas where it may be introduced satisfy most of these criteria, as follows:

Criterion 1: Appearance in local regions where not found previously. As discussed above, *A. dorsalis* has been collected in several regions that were relatively well sampled prior to its appearance, in particular California, Oklahoma, the upper Midwestern states, South Carolina (Savanna River site), Virginia, and central Colombia.

Criterion 2: Initial expansion of local range subsequent to introduction. Unfortunately, there are insufficient regional surveys to document in detail the appearance or disappearance of this species. However, the geographical and temporal pattern of the records of *A. dorsalis* in reservoirs in Oklahoma, Texas, and Arkansas hints that this species may have been able to expand its range in that region, and possibly northwards from there. The pattern in central Colombian reservoirs is similar.

Criteria 3 and 4: Association with human mechanism(s) of dispersal; and association with or dependency on other introduced species. As discussed above, *A. dorsalis* is closely associated with cultured and stocked fish, and also possibly with transport of ornamental aquatic plants.

Criterion 5: Prevalence or restriction to new or artificial environment(s). Outside its supposed core range, *A. dorsalis* is almost exclusively found in fish-culture ponds and other constructed waterbodies including large reservoirs.

Criterion 6: Relatively restricted distribution on a continent compared to distributions of native species. Even in Oklahoma, northern Texas, and central Arkansas, the records of *A. dorsalis* are rather discontinuous, and it has not been reported from many apparently suitable habitats (such as by Robertson, 1970, 1972). Outside this region, the records are geographically distant from each other.

I speculate that the original range of *A. dorsalis* included mainly ponds and lakes in the warm lowlands around the Gulf of Mexico and the Caribbean, from the southern United States possibly to northwestern Colombia, and including Cuba and Dominica. Occasionally, populations may have been able to establish slightly farther north, as for instance in central Mississippi. From there, it was passively transported and succeeded in establishing itself in the Mexican and Colombian highlands, one location in Venezuela, and several locations in the United States, most successfully in the lower Mississippi basin (Texas, Oklahoma, Arkansas), and then as far north as Missouri, Indiana, and Michigan. There it could be classified as a stage IVb invader (localized but dominant) sensu Colautti & MacIsaac (2004).

The movements of *A. dorsalis* and the other calanoids that are expanding their ranges may be promoted by some of the same factors. Passive transport, especially via the operations of warmwater-fish hatcheries, seems to have played the primary role. Another factor may be the proliferation of impoundments, many of them eutrophic, and the eutrophication of many natural waterbodies.

Particular biological traits of *A. dorsalis* that could have facilitated these movements include its propensity for eutrophic conditions, wide range of food items, and resistance to fish predation. Genetic selection may have also played a part, as in the case of *E. affinis* (Lee, 1999; Lee & Bell, 1999).

The rapid changes in aquatic habitats – their creation, eutrophication, and introduction of exotic fauna and flora – caused by humans over the past century have facilitated the entry and establishment of many species into regions and habitats where they were not formerly present. These changes may be allowing *A. dorsalis* to expand its range.

ACKNOWLEDGMENTS

My warmest thanks for the hospitality and information provided by the National Park Service, U. S. Geological Survey (National Biological Service), Anacostia Watershed Society, and New Columbia Audubon Society, sponsors of the 1996 BioBlitz in the Kenilworth Park and Aquatic Gardens, and especially Mr. Stephen W. Syphax, now Chief of the Resource Management Division, National Capital Parks - East, U.S. National Park Service, Washington, D.C., and Mr. Sam Droege, now Biologist, U.S.G.S. Patuxent Wildlife Research Center, Maryland; Mr. Kenneth D. Mitchell, Assistant Warmwater Hatchery Superintendent, Vic Thomas Striped Bass Hatchery, Virginia Department of Game & Inland Fisheries, Brookneal, Virginia; Mr. Christopher Dahlem, Superintendent, and Mr. Michael Vest, King and Queen Fish Cultural Station, Virginia Department of Game & Inland Fisheries, King and Queen County, Virginia; Mr. Michael Odom, Project Leader, and Mr. David L. Peterson, Biologist, Harrison Lake National Fish Hatchery, U.S. Fish & Wildlife Service, Charles City County, Virginia; and Mr. Dan

Jessup, Manager, Cikana State Fish Hatchery, Indiana Department of Natural Resources, Morgan County, Indiana. Drs. Glenn Carter, Research Associate, University of Michigan; Danielle Defaye, Muséum national d'Histoire naturelle, Paris, France; Lloyd C. Fitzpatrick, University of North Texas, Denton, Texas; Dagmar Frisch, Doñana Biological Station, Seville, Spain; Santiago Gavíria-Melo, Technisches Büro für Biologie, Vienna, Austria; J. David Hambright, University of Oklahoma Biological Station, Kingston, Oklahoma; Patrick L. Hudson, U.S.G.S. Great Lakes Science Center, Ann Arbor, Michigan; William E. Kelso, L.S.U. Agricultural Center, Louisiana State University, Baton Rouge; Joel W. Martin and George Davis, Natural History Museum of Los Angeles County, California; James J. Orsi, Stockton, California; Andrew Robertson, Tucson, Arizona; Eduardo Suárez-Morales, ECOSUR, Chetumal, Mexico; Byron Torke, Muncie, Indiana; Adrienne DeBiase, Savannah River Ecology Laboratory, South Carolina; and especially Stanley I. Dodson, University of Wisconsin, Madison, cordially provided information, literature references, and helpful comments. I am grateful to Dr. Marco F. Suárez, then of San Juán Laboratories, for his gifts of copepod specimens from Puerto Rico and Colombia to the National Museum of Natural History; and to Dr. Jo Sadler, Extension Fish Health Specialist, and Mr. Sathyanand Kumaran of the Cooperative Extension Fish Health Diagnostic Services Aquaculture/Fisheries Center, UAPB, Lonoke, Arkansas, for their permission to include the record from ponds at the Center, and to deposit specimens in the Virginia Museum of Natural History. Mr. T. Chad Walter provided information from the C. B. Wilson Copepod Library, National Museum of Natural History. Comments from Dr. Steven M. Roble and an anonymous reviewer resulted in material improvements to the manuscript. Collections in Virginia were made under Virginia Department of Game and Inland Fisheries Scientific Collection Permit No. 026722 (2005-2006).

This work is dedicated to the memory of the late Dr. Edward B. Reed, mentor and friend, in recognition of his many contributions to limnology in North America, and particularly to the knowledge of our copepod fauna.

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Banisteria, Number 30, pages 19-26
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Exotic Plant Distributions along Disturbance Corridors at the Grassy Hill Natural Area Preserve, Franklin County, Virginia

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ABSTRACT

The Grassy Hill Natural Area is a mountain preserve containing forest, open woodland, grassland, and rock outcrop habitats northwest of Rocky Mount, Virginia. The preserve was created in 1999 and is managed by the Virginia Department of Conservation and Recreation to protect forest communities and rare plant species. In 2005, nine 0.25-ha plots were randomly established in forestlands located along disturbance corridors traversing the preserve. Plots were sampled for exotic plant species richness and frequencies to assess exotic presence and encroachment into the preserve from the corridors. Exotic species richness was low in all plots, but was highest closest to corridor edges. Exotic species were not widely distributed across corridors, except for Tree of Heaven (*Ailanthus altissima*) and Japanese Stilt Grass (*Microstegium vimineum*), which were found along all corridors. Silk Tree (*Albizia julibrissin*), an exotic hawthorn (*Crataegus* sp.), Chinese Privet (*Ligustrum sinense*), and Japanese Honeysuckle (*Lonicera japonica*) were present in a few plots. Eleven other exotic species were encountered along the corridors, outside of the plots. While the plots were dominated by native plants and had low exotic species richness and invasion, high frequencies of the aggressively invasive *M. vimineum* along corridor edges, and encroachment by *A. altissima* into the forest, suggest that invasion by these and other exotic species could increase with potentially negative consequences for forest community integrity and native plant conservation at the preserve.

Key words: diversity, exotic invasive plants, Grassy Hill Natural Area Preserve, plant conservation, Virginia.

INTRODUCTION

Exotic plants are common in many habitats in the United States (Yahner, 1995), but are highly prevalent in temperate forests in the eastern U.S. that are fragmented due to agriculture, logging, and road building (Brothers & Spingarn, 1992). Fragmented forests can harbor relatively intact native plant communities, and are important reservoirs of native plant diversity. However, over time, exotic plants commonly invade fragmented forests. The exotic tree species Norway Maple (*Acer platanoides*) and Tree of Heaven (*Ailanthus altissima*), the shrubs Japanese Barberry (*Berberis thunbergii*) and Winged Burning Bush (*Euonymus alata*), the grass Japanese Stilt Grass (*Microstegium vimineum*), and the forb Japanese Knotweed (*Polygonum cuspidatum*), for example, are well established in Virginia forests (Virginia Department of Conservation and Recreation & Virginia Native Plant Society, 2003). Exotic plant encroachment can reduce native plant abundance and upset community structure (Claridge & Franklin, 2002) with cascading effects on native animals that depend on these plants for food, nests, and shelter (Yahner, 1995). Ultimately, effects from exotic plant invasion into fragmented forests are twofold: the potential loss of ecological stability in some native communities and of native plant species diversity.

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The success of exotic plant recruitment into fragmented forests is generally related to life history traits that may favor exotic species over native ones and to disturbance from fragmentation (Brothers & Spingarn, 1992; Worley & Tyser, 1992). Exotic plants often produce more seeds and grow faster than do many natives (Rejmanék & Richardson, 1996), which can lead to competitive exclusion of natives by exotics. Human disturbances are also influential, primarily because they can cause environmental changes. Forest fragmentation can increase light availability and disrupt soil along fragment edges, for example. The resulting "edge effects" can assist exotic recruitment along disturbed canopy edges (Brothers & Spingarn, 1992), though native species may also benefit. However, the degree to which fragmentation influences exotic distributions in many forests has not been fully investigated. This is especially true for mountain forests that, due to topography, are often less fragmented than forests found at lower elevations.

Although many surveys have documented exotic plants in Virginia forests in general, fewer have assessed exotics in Virginia mountain forests, especially those established to conserve important closed-canopy forest communities (e.g., Mountain Piedmont Acidic Woodlands) and open woodland and grassland communities (e.g., Piedmont Prairie). This study sought to survey exotic plants in the Grassy Hill Natural Area Preserve (Grassy Hill), a Blue Ridge Mountain sanctuary containing many important forest, open woodland, and grassland communities, but which has not been studied for exotic plant presence and invasion. Specifically, we surveyed exotic plants in the areas of the preserve most disturbed by human activity. Our primary goals were: (1) to identify and quantify exotic plant species richness and frequencies in plots located along disturbance corridors in the preserve and (2) to assess encroachment by exotic species into closed-canopy forest interiors adjoining the corridors. We also surveyed exotic species along the corridors, outside of the plots, to assess their presence along the corridors in general. We hypothesized that exotic species richness and frequencies would differ between corridor types and across transects. Specifically, we hypothesized that exotic plant richness and frequencies would be higher in the most disturbed plots (i.e., paved and gravel road plots) and in transects closest to corridor edges compared to those in forest interiors.

SITE DESCRIPTION

Grassy Hill is a 524-ha preserve located northwest of Rocky Mount, Franklin County, Virginia, 32 km south of Roanoke. The Virginia Department of Conservation and Recreation (VDCR) has managed the preserve since 1999 as part of its Natural Area Preserve system. Grassy Hill lies in the foothills of the Piedmont physiographic province (Roberts & Bailey, 2000), and contains magnesium-rich bedrock overlain with mafic soils (Virginia Department of Conservation and Recreation, 2003). The terrain is mountainous, with northwest-southeast oriented slopes ranging in elevation from 365-535 m asl (U. S. Geological Survey & Virginia Division of Mineral Resources, 1985). Annual precipitation averages 106 cm, and monthly average temperatures range from 3-24 ºC (Town of Rocky Mount, 2006). The preserve is in the southern oak-pine forest zone (Yahner, 1995), and is dominated by hickory (*Carya*), oak (*Quercus*), and pine (*Pinus*) species. Grassy Hill contains important ecological forest communities (i.e., Mountain Piedmont Acidic Woodland and Basic Oak-Hickory Forest) recovered from logging, and is likely named for grassland habitats that occurred on the mountain before logging and fire suppression altered pre-settlement conditions (Virginia Department of Conservation and Recreation, 2003). Today, the preserve is primarily composed of closed-canopy forest communities, with some open woodland and grassland habitats, as well as disturbed areas such as road corridors and power line right-of-ways. The xeric soils in some open woodland and disturbed areas provide habitats for rare grassland plants like Smooth Coneflower (*Echinacea laevigata*), a federally listed endangered species. The proximity of this and other rare native plants to disturbance corridors at Grassy Hill is a major reason why our study is of importance, since ironically, disturbed areas favoring some native plants can also act as conduits for exotic species invasion. There are no records of fire, logging, or other major disturbances (other than occasional pest outbreaks) since the mid-20th century at the preserve (J. Ebbert, Virginia Department of Forestry; pers. comm.). However, corridor fragmentation is a source of ongoing disturbance and forest management plans may include additional disturbances that will be needed to facilitate the restoration of some habitats to early successional conditions. Balancing these management goals while discouraging exotic recruitment is, thus, important.

METHODS

In the summer of 2005, nine 0.25-ha plots were randomly established at Grassy Hill along three corridors: (1) a heavily traveled paved road (VA Route 919), (2) a rarely used gravel access road, and (3) an old abandoned dirt logging road. No plot was located within 500 m of another, and all but two plots were more than 750 m apart. All plots were within 100 m in

elevation and had a northwest aspect. Plots were similar in tree composition, and were dominated by hickories and oaks. Within each plot, five 50 x 4 m belt transects, each subdivided into 4 x 5 m quadrats, were established using the procedures of Brothers & Spingarn (1992) to create a transect gradient based on proximity to corridor edge. Transects were placed parallel to corridors beginning at (-2) - 2 m, and then 2 - 6, 10 - 14, 20 - 24 and 45 - 49 m into the forest from corridor edges. Transects were labeled T(-2), T2, T10, T20, and T45 accordingly. T(-2) was established 2 m outside of the forest edge to account for irregularities in edge linearity. However, no T(-2) transect overlapped the corridor area, since corridor edges included dirt shoulders.

Sampling was conducted from June to August 2005, and exotic plants were identified following Harrar & Harrar (1962), Petrides (1986), and Huebner et al. (2005). Identified plants were considered exotic and invasive if listed in the Invasive Alien Plant Species of Virginia (Virginia Department of Conservation and Recreation & Virginia Native Plant Society, 2003). In each transect quadrat, exotic shrubs, tree seedlings, tree saplings, and canopy trees were counted, as were stems of forbs. Grasses were counted by ramet. Native tree species were also identified and marked as present, but were not counted. Additionally, exotic species were identified along each corridor outside of the plots, and noted as present during foot walking surveys consisting of visual examinations of ca. 10 m of forest interior beyond corridor edges.

Canopy cover and leaf litter depth were measured in mid-July in the center of each transect quadrat to evaluate if they might influence exotic presence. Canopy cover was measured 1.5 m above ground level, using a hand-held mirror densiometer. Litter depth was measured with a metric ruler as the distance from the bottom duff layer to the top of the leaf layer.

CALCULATIONS AND ANALYSES

Exotic species richness was calculated as the number of exotic species encountered per corridor type and transect, while exotic species frequencies were calculated as the percentage of quadrats in which exotic species were encountered. Frequencies were determined for all exotic species. Log-linear analyses were conducted to test for effects of (1) corridor type on *Ailanthus altissima* and *Microstegium vimineum* frequencies because they were the only exotic species found across corridor types and (2) proximity to corridor on *A. altissima* frequencies, because it was the only exotic species found beyond T2 transects at relatively high frequencies. Tests were considered significant if $P \leq 0.05$.

RESULTS

Six exotic plant species were identified in our plots (Table 1). The most commonly encountered were *A. altissima* and *M. vimineum*, both of which were established in plots along each corridor. *Ailanthus altissima* occurred primarily as sparsely dispersed saplings, whereas *M. vimineum* occurred in patchy clusters. The other four species were much less common, and were observed as saplings, small trees, bushes, or vines. Eleven other exotic species were found along corridors, outside of plots, suggesting that exotic encroachment in the preserve may be greater than that represented by the plots. Most of these species were found along paved and gravel road shoulders, and included the following forbs: Wild Garlic (*Allium vineale*), Canada Thistle (*Cirsium arvense*), Bull Thistle (*Cirsium vulgare*), Crown Vetch (*Coronilla varia*), White Sweet Clover (*Melilotus alba*), Curly Dock (*Rumex crispus*) and Common Chickweed (*Stellaria media*). Three grasses, Orchard Grass (*Dactylis*

Table 1. Exotic plant species presence across corridors and transects at Grassy Hill Natural Area Preserve, Franklin County, Virginia. The numbers -2, 2, 10, 20, and 45 represent transect distance (in m) from the corridor edge. X indicates species presence in transects.

Road Corridor / Species	Paved					Gravel					Logging				
	-2	2	10	20	45	-2	2	10	20	45	-2	2	10	20	45
Ailanthus altissima	x	x	x	x	x	x	x	x	x	x	x			x	x
Albizia julibrissin	x	x				x	x								
Crataegus sp.						x									
Ligustrum sinense						x	x								
Lonicera japonica						x									
Microstegium vimineum	x					x	x				x				

Table 2. Total exotic plant species richness and frequency between corridors and across transects. The numbers -2, 2, 10, 20, and 45 represent transect distance (in m) from the corridor edge.

Road Corridor / Variable	Paved	Gravel	Logging
Exotic species richness	2	4	2
Exotic species frequency (%)	26	23	11

Transect / Variable	-2	2	10	20	45
Exotic species richness	6	4	1	1	1
Exotic species frequency (%)	72	14	8	9	9

Table 3. Mean percent canopy cover and leaf litter depth across corridor transects. The numbers -2, 2, 10, 20, and 45 represent transect distance (in m) from the corridor edge.

Transect / Variable	-2	2	10	20	45
Mean canopy cover (%)	82.2	91.0	94.6	98.0	98.4
Mean leaf litter depth (cm)	0.9	3.9	3.6	4.1	4.6

glomerata), Tall Fescue (*Festuca arundinacea*), and Timothy (*Phleum pratense*) were common along the paved road. White Mulberry (*Morus alba*) also occurred along the paved road.

Consistent with our hypotheses, exotic species richness differed among corridors, being higher in gravel road plots than in paved or logging road plots (Table 2). Two species were found in plots along all three corridors (*M. vimineum* and *A. altissima*), one was found in plots along paved and gravel roads (*Albizia julibrissin*), and three were found only in gravel road plots (an exotic *Crataegus* species, *Ligustrum sinense*, and *Lonicera japonica*; Table 1). Frequencies of exotic species were similar between the paved and gravel road plots, and were more than twice the frequencies found in the logging road plots (Table 2). However, a log-linear analysis of both species found in all three corridors found no effect of corridor type ($P < 0.05$) on their frequencies. Also consistent with our hypotheses, exotic species richness was highest in transects located closest to corridors, with species richness per transect declining from six in T(-2) transects to one in T45 transects (Table 2). Similarly, exotic species frequencies declined from 72% in T(-2) transect quadrats to 9% in the T20 and T45 transects. Mean *A. altissima* frequency also conformed to this pattern, falling from 37% in T(-2) quadrats to 12% in T45 quadrats (Fig. 1). Not surprisingly, a log-linear analysis found a significant effect of proximity to corridor on *A. altissima* frequency ($P < 0.05$), indicating that the frequencies of this species were significantly higher in transects closest to corridors compared to those located farther into the forest interior. *Microstegium vimineum* had the highest frequency of any exotic in any transect, occurring in 58% of T(-2) quadrats, but it was virtually absent from all other transects across corridors, as were the other exotic species. *Albizia julibrissin*, *Crataegus* sp., *L. sinense*, and *L. japonica* occurred in 12, 2, 1, and 1% of T(-2) transect quadrats on average, respectively. Due to the very low frequencies of all exotic species except *A. altissima* beyond the T(-2) transects, log-linear analyses of the effect of proximity to corridor were not conducted for any of those species.

The forest environment also differed between exterior and interior transects across corridors (Table

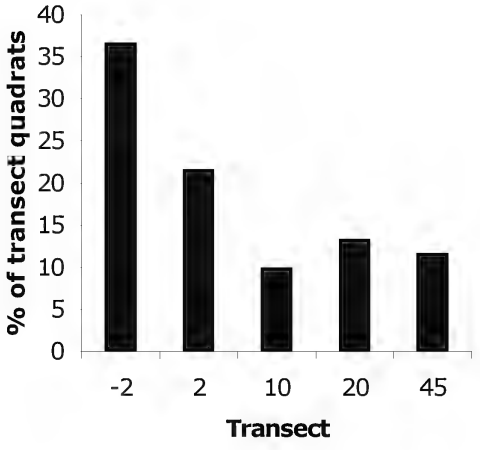

Fig. 1. *Ailanthus altissima* frequency across corridor transects.

3). Mean canopy cover increased from 82.2% in T(-2) transects, which is relatively high for forest edges, to almost complete cover (98.4%) in T45 transects. Mean leaf litter depth varied greatly between transects, being 3.7 cm more in T45 than in T(-2) transects (Table 3). Thus, across corridors, light availability and litter depth both decreased with distance from corridor edge.

DISCUSSION

The presence of 17 exotic plant species along disturbance corridors at Grassy Hill is evidence that exotic plant species have recruited there. While only six species were found in our plots, four are highly invasive in Virginia mountain communities (i.e., *Ailanthus altissima*, *Ligustrum sinense*, *Lonicera japonica* and *Microstegium vimineum*; Virginia Department of Conservation and Recreation & Virginia Native Plant Society, 2003), as is *Cirsium arvense*, which was found along corridors outside of our plots. *Microstegium vimineum* in particular has been found to be highly invasive in Appalachian mountain forests, replacing most native ground vegetation within a few years of encroachment in areas where it establishes (Gibson et al., 2002). Given the goal of the VDCR Natural Heritage program to conserve natural communities, encroachment by *M. vimineum* and other exotics into important forest communities at the preserve could occur over time with potentially negative consequences for community integrity and native plant diversity.

Exotic encroachment beyond corridor edges was not extensive as of this study, however, since most exotic species were only prevalent in T(-2) transects. Furthermore, encroachment by *A. altissima*, the only species found at frequencies greater than 10% beyond T(-2) transects, was still significantly greater in T(-2) transects than in forest interior transects. These results are consistent with similar studies examining exotic invasion along disturbance corridors in low elevation habitats (Brothers & Spingarn, 1992; Tyser & Worley, 1992). The maximum exotic species richness and frequencies along roadside transects likely reflect recruitment success following accidental and purposeful human disturbance (Tyser & Worley, 1992). For example, vehicles carrying gravel or soil can accidentally introduce exotic seeds along roads, which can then germinate and colonize (Schmidt, 1989). Road plowing also aids exotic colonization via soil disruption, which is correlated with exotic establishment and population growth (Tyser & Key, 1988; Tyser & Worley, 1992). This may explain why total exotic richness was greatest in the gravel road plots in our study; this road was more recently disturbed by soil disruption than were the other corridors.

High *M. vimineum* frequencies along gravel road T(-2) transects, for example, likely reflect recent disturbance there, because extensive plowing was evident and extended to forest edges where grass frequency was highest. It is possible that *M. vimineum* seed was accidentally introduced in imported gravel and colonized disturbed soil alongside the gravel roadbed. Similarly, high *M. vimineum* frequencies in T(-2) transects along the paved road may reflect disturbance from shoulder maintenance that includes periodic plowing and gravel application. Furthermore, in mixed-use preserves such as Grassy Hill, recreational pursuits, such as horseback riding can introduce and assist exotic grass colonization through manure droppings and by soil trampling (Cole, 1987; Hall & Kuss, 1989). Horseback riding was documented at Grassy Hill before this study began (G. Turner, pers. obs.), especially on the gravel road, although it is now restricted. However, seed introduction and soil trampling from horses in the recent past on this road, as well as the logging road, which has experienced little other recent soil disturbance, may have assisted *M. vimineum* colonization.

Other exotic species, like *L. sinense* and a *Crataegus* species, which are only present in one plot along the gravel road, probably recruited from seeds dispersed from plants found at homes located near this road. The presence of species along corridors, outside of plots, such as *Cirsium* species, *Dactylis glomerata*, *Festuca arundinacea*, and *Melilotus alba* may reflect their escape from local pastures, which are located along the paved road less than 1.6 km west of the preserve. Conversely, *Coronilla varia and F. arundinacea*, common along the paved road, are present due to purposeful seeding by the Virginia Department of Transportation (C. B. Reynolds, Virginia Department of Transportation; pers. comm.) for erosion control, a common practice documented as a cause of exotic introduction (Tyser & Worley, 1992).

Although factors such as human soil disturbance and seed dispersal may have favored exotic recruitment on corridor edges at Grassy Hill, low encroachment into the forest interior by *C. varia* and most of the other exotic species likely reflects unfavorable environmental conditions, such as shade, that restrict invasion. For example, growth of *C. varia* is generally inhibited by high shade (National Biological Information Infrastructure & Invasive Species Specialist Group, 2005), a condition found across most transects in this study. However, the other exotic species found in our plots (except *A. altissima*), are relatively shade tolerant, and *M. vimineum* is a moderately shade tolerant plant (Barden, 1987; Cole & Weltzin, 2005; National

Biological Information Infrastructure & Invasive Species Specialist Group, 2005) whose establishment is restricted only by dense midstory canopy. Thus, other factors, perhaps including leaf litter, are likely restricting encroachment by these species.

We found a large increase in mean leaf litter depth from the T(-2) transects (0.9 cm) to the T2 transects (3.9 cm), and a further increase in depth into the forest interior (Table 3). It is possible that the deeper leaf litter found beyond corridor edges acts as a barrier to exotic encroachment for most of the species that we documented, because many exotics need bare soil for successful establishment (Harper, 1977). Perhaps other soil factors restrict exotic encroachment. For example, *M. vimineum*, prefers mesic soils (Barden, 1987; National Biological Information Infrastructure & Invasive Species Specialist Group, 2005) such as those found along corridor edges where water can pool in depressions, and may be restricted by lower soil moisture conditions that may be found in forest interiors. It is also possible that exotic invasion into forest interiors in this study was restricted by low disturbance in those habitats, which has been suggested as a factor restricting exotics (Brothers & Spingarn, 1992).

Finally, and perhaps most interesting, was the widespread encroachment of *A. altissima* into forest interiors, even though it was significantly greater in T(-2) transects compared to forest interior transects. As the only exotic species found beyond T2 transects, its distribution follows models of exotic invasion (Rejmanék, 1989; Rejmanék & Richardson, 1996), but based on its low frequencies in interior transects, its diffusion is minor. *Ailanthus altissima* may be a more successful invader of forest interiors than the other exotic species found in our study plots because of its prolific seed set (Virginia Department of Conservation and Recreation & Virginia Native Plant Society, 1999), airborne seed dispersal, and shade tolerance plasticity (Kowarik, 1995). In fact, *A. altissima* saplings found in T20 and T45 transects along the logging road were growing in highly shaded rock outcrops far from canopy trees that likely serve as seed sources.

CONCLUSIONS

Results from this study indicate that exotic plant species occur along disturbance corridors at Grassy Hill, but that encroachment off of corridors into the preserve's intact forest communities was not extensive, probably due to high shade and deep leaf litter found in forest interiors. While a lack of exotic species invasion may be good news in terms of managing closed-canopy forest communities, long-term management practices including modification of some closed-canopy stands in order to restore open woodland and grassland habitats, for example, might be considered with caution, since these methods could potentially promote recruitment into "opened" stands by exotic species currently found only along preserve corridors.

Proposed harvesting methods such as canopy thinning, for example, used to reduce forest stand density and promote open woodland habitats, could promote recruitment by desired native woodland and grassland species. However, this method has also been shown to promote exotic recruitment (Bartuska 1994; Cook 1998). Proposed prescribed burning and fireline construction, meant to restore and maintain native grassland habitats, could also promote exotic invasion if a "targeted native restoration" seed bank is absent or reduced (Huebner 2003), which is likely at the preserve given its post-settlement alteration to closed-canopy forest for many years (Virginia Department of Conservation and Recreation, 2003). Therefore, thinning and burning to promote new open canopy habitats to assist native plant recruitment and diversity could inadvertently promote exotic recruitment as well, because exotic species already present along preserve corridors could colonize the mineral soils of prescribed burn areas and firelines. While restoring open woodlands and grasslands at the preserve is desirable, and could return some habitats to a semblance of pre-settlement conditions, it should be done so with plans to restrict exotics, especially if native recruitment is not initially successful.

In addition to monitoring exotics in areas targeted for open woodland restoration, monitoring and managing exotics in important closed-canopy forest communities not targeted for restoration should also be made, since exotics found along preserve corridors could eventually invade into these forest communities. *Microstegium vimineum*, for example, has been shown in some studies to exhibit little forest invasion after establishing along forest edges, only to later invade forest interiors (Barden, 1987). Further, other shade tolerant exotics such as the herb *Alliaria petiolata* and the shrub *Euonymus alata*, both documented as "highly invasive" in Virginia mountains (Virginia Department of Conservation and Recreation & Virginia Native Plant Society, 2003) besides Grassy Hill, could potentially recruit into forest communities at the preserve. Ultimately, the management of native communities and the restoration of open woodland and grassland communities should incorporate careful monitoring of present and potential exotic species to ensure that they do not threaten restoration and long-term management of natural communities at this preserve.

ACKNOWLEDGEMENTS

We wish to thank Mike Leahy, former steward at the Grassy Hill NAP, for his assistance and advice. We also thank Winfield Fairchild for his technical assistance. Collecting of plant specimens was made possible by the Virginia Department of Conservation and Recreation, Division of Natural Heritage, Research and Collecting Permit No. DNH-MTR02-05. A West Chester University, College of Arts and Sciences, Support and Development Award funded the project.

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Banisteria, Number 30, pages 27-31
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Four May Beetles New to the Virginia Fauna (Coleoptera: Scarabaeidae: Melolonthinae)

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ABSTRACT

Four species of *Phyllophaga* are documented for Virginia for the first time: *P. nitida* (LeConte) from Scott County, and *P. latifrons* (LeConte), *P. prununculina* (Burmeister), and *P. postrema* (Horn) from various localities in the Atlantic Coastal Plain. The first is generally distributed in the northcentral states and southern Canada west of the Appalachians, the other three are recorded from Florida to New Jersey. Drawings for the metatibial apex of males are given for *P. nitida* and *P. postrema*, as well as illustrations of the everted aedeagus ("internal sac") for these species plus *P. prununculina, P. drakii* (Kirby), and *P. fusca* (Palisot de Beauvois).

Key words: aedeagal structure, beetles, *Phyllophaga*, Scarabaeidae, Virginia.

During the course of processing beetles in the Virginia Museum of Natural History collection, I recently identified several species of May beetles (genus *Phyllophaga*) apparently not so far documented as members of the Virginia insect fauna. Considering the deficient state of our knowledge of most arthropod groups in the Commonwealth, such discoveries are not particularly noteworthy *per se*, unless, as in the present case, substantial refinements of the known range are involved.

The occasion is taken to illustrate some important diagnostic characters previously represented only verbally or not at all. Although the male genitalia of these species were depicted photographically by Luginbill & Painter (1953), the small size of the images detracted from their usefulness and, for most species, only the configuration of the heavily sclerotized terminalia was shown.

While preparing specimens for examination of the male genitalia, I studied the aedeagal vesicle of several species for possible supplementary diagnostic characters, inasmuch as this normally concealed part of the male genitalia has proven to be of great taxonomic importance in other beetle groups (e.g., Carabidae) and by analogy might be expected to be useful in distinguishing species of *Phyllophaga*.

[1]The aedeagus was illustrated even earlier for the Louisiana species of *Phyllophaga* in a doctoral dissertation by E. G. Riley, submitted in 1988, which, being unpublished, does not have priority over the work by Woodruff & Beck in this context.

Phyllophagan aedeagi

Although the sclerotized abdominal copulatory apparatus of male scarab beetles has been employed to distinguish species for over a century (e.g., Smith, 1889), the possible taxonomic value of the aedeagus has only recently been addressed. One hundred years after Smith's pioneering utilization of the genitalia in *Phyllophaga*, Woodruff & Beck (1989)[1] presented a number of intriguing illustrations of the aedeagi of several species, as prepared in the everted condition for SEM imaging. While their procedure for producing permanent and fixed eversion produces excellent results, it is rather time-consuming and tedious. In many cases, a quick and easy approach yields excellent results for examination of these membranous structures. In the species which I have prepared in this context, simply immersing the genital capsule dissected from a pinned specimen in a weak solution (about 10%) of sodium hydroxide usually results in complete extrusion by osmotic pressure in just a few minutes. In some cases, longer time is required, and the process can also be expedited by careful manipulation of the sac with a fine insect pin. Neutralization of the caustic agent in boiled or distilled water (to avoid air bubbles) may also enhance inflation of the sac, again by osmotic effect. Storage in glycerin in a microvial has not caused evident shrinkage by removal of the water. While obviously not suited for SEM studies, this procedure gives

very acceptable results for visual examination and drawing. Specimens initially preserved in any solution containing formalin (often employed in pitfall traps) will not always give optimal results with this technique. The beetles which I studied were collected by UV light traps, using a preservative based on isopropyl alcohol. Specimens killed with ethyl acetate might yield the best results.

The prominent, sclerotized distal copulatory elements of the male genitalia in beetles are traditionally referred to as parameres (sometimes as penis or phallus). Since, in many kinds of *Phyllophaga* the two parameres are fused at the base (sometimes also apically) into a single unit, the name ***symparameres*** would seem a useful distinction. The transverse basal region is extended internally as a thin, sclerotized, conchoidal structure referred to as the *apodeme (cf.* Snodgrass, 1935, fig. 303C), which is provided with internal muscles for extension or flexion of the parameres (if they are moveable). The apodeme also contains a long, narrow, frequently doubled, median acicular sclerite designated by Snodgrass as the *aedeagal apodeme*, a continuation of the sclerotized basal part of the aedeagus. While this is true for the species he illustrated (*P. chiriquiana*) and others such as *P. prununculina* and *P. glaberrima*, the majority of eastern species known to me, including those illustrated herein, lack this modification and the internal apodeme is only loosely attached, if at all, to the vesicular region (the aedeagus in the strict sense). To avoid the complication of having a small "apodeme" operational inside another, larger one, I propose to use the new name ***baculum*** for the smaller internal structure which seems to be functionally analogous to the baculum bone that supports the penis of many kinds of mammals. I am not aware that the term has been used previously in an entomological context.

That a functional relationship exists was suggested by the fact that gentle pressure with the head of an insect pin on the "inner apodeme" often resulted in enhanced inflation of the vesicle when the entire structure was immersed in fluid. The details of this structure, and its modification into the condition illustrated by Woodruff & Beck (1989, fig. 449) and Figures 9 and 10 of this paper for *P. prununculina*, are being investigated for a more detailed future treatment, at which time the possible effects of geographic variation on form and armature of the aedeagus may also be considered.

Phyllophaga nitida (LeConte) Figures 1-2.

As depicted by Luginbill & Painter (1953), the range of this species extends across the southern edge of Canada from Alberta to Quebec, thence southward into the states of Minnesota, Wisconsin, Michigan, Ohio, Illinois, and Iowa (with an unattributed disjunct record for Georgia). West Virginia was added to this distribution by McCutcheon et al. (1994). VMNH has a male specimen from the following locality:

VIRGINIA: *Scott County*: Co. Rt. 653, ca. 0.2 km west of junction with Rt. 602 (ca. 8.2 km west of Dungannon), 24 June 2004, Anne C. Chazal. This site is approximately halfway between West Virginia and Georgia and thus lends some credence to the occurrence of *P. nitida* in the latter state. It also emphasizes the presence in southwestern Virginia of organisms typically native to the Interior Lowlands of North America.

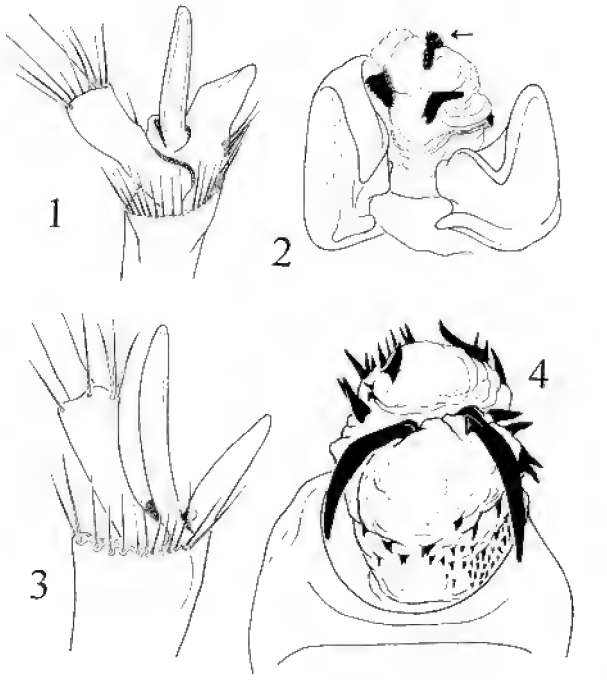
The lower (fixed) male metatibial spur (Fig. 1) is notably broad and subtriangular, angulate at midlength, and much wider than the upper spur. Both are thin and laminate, and together originate at the tibial apex somewhat produced beyond articulation of the basitarsus. The aedeagus (Fig. 2) is relatively small and does not expand out beyond the symparameres; its ornamentation consists of four small, irregular black sclerites with dentate or serrulate edges. In the extruded condition, these sclerites are most evident in a caudoventral aspect, from which the drawing was prepared. A possibly diagnostic feature not mentioned in descriptions of this species is that the scutellum is completely impunctate (at least in the specimen at hand), a condition not noted by me in any of the 24 other local species examined.

Phyllophaga postrema (Horn) Figures 3-5.

Originally described from "Florida," this species occupies a range in the southeastern Coastal Plain from eastern South Carolina to central Florida, thence westward to southern Mississippi (Woodruff & Beck, 1989). The species has been recently reported from Chatsworth, New Jersey by Robbins et al. (2006), so its capture in eastern Virginia merely fills in the lacuna that existed between New Jersey and South Carolina. The Virginia beetles agree in all external details, including those of the symparameres, with the good description and figures published by Woodruff & Beck (1989: 145, figs. 44, 104, 164, 224, 257, 347, 350, 451, and 564).

VIRGINIA: *Accomack County*: Assateague Island, Chincoteague National Wildlife Refuge, UV trap at "cattle gate marsh", 24 June 1998, S. M. Roble (VMNH 1♂). *City of Virginia Beach*: False Cape State Park, Barbour Hill entrance road at south end of marsh, live oak forest edge, 31 May 2005, Roble (VMNH 13♂♂).

Lower metatibial spur of males (Fig. 3) fused, symmetrically tapered distal, about 2/3rds as long as the upper spur, which is slightly but evidently curved ventrad, broadest near distal third, and substantially longer than basal tarsomere. Aedeagus (Figs. 4-5) with two long,



Figs. 1, 2. *Phyllophaga nitida* (LeConte), specimen from Scott County, Virginia. 1. Apex of metatibia showing configuration of fixed spur and origin of articulated spur somewhat *distad* to base of first tarsomere. 2. Male genitalia, posteroventral aspect with everted aedeagus. There are no sclerites except those shown, but the narrow, dorsal, spiculate sclerite (arrow) extends for some distance proximad along the upper side of the vesicle. Figs. 3, 4. *Phyllophaga postrema* (Horn), specimen from Accomack County, Virginia. 3. Apex of metatibia of male. 4. Everted aedeagus, dorsal aspect showing the two large paramedian spines. All major armature is shown in this aspect.

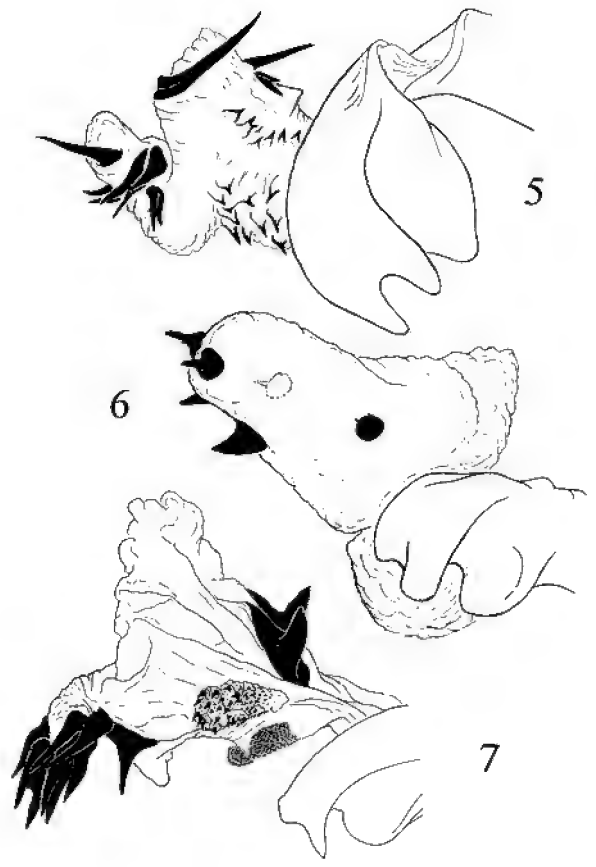


Fig. 5. *Phyllophaga postrema*, same specimen as in Fig. 4, lateral aspect of right paramere and everted aedeagus. Fig. 6. *Phyllophaga fusca* (Palisot de Beauvois). Specimen from Martinsville, Virginia. Everted aedeagus, right lateral aspect. The single spine on the left side is indicated by dotted lines. Fig. 7. *Phyllophaga drakii* (Kirby). Specimen from Richmond, Virgina. Everted aedeagus, right lateral aspect.

slender spines on the dorsal side and numerous small, subequal black spines dispersed generally over the surface.

Woodruff & Beck (1989) noted the external similarity of this species to *P. ulkei* (Smith) and *P. drakii* (Kirby), and all three also have the same general symparamere structure. Those authors provided excellent SEM photographs (Figs. 442-445) of the expanded aedeagus of *P. ulkei*, notable for the two elongated basal spines on the dorsal surface. Two similar spines are present in the same position in *P. postrema*, but this species differs in the presence of a large number of prominent black aedeagal spicules. In the inflated condition, the aedeagus forms two distal lobes, the proximal bearing the elongated paramedian spines, while the distal lobe and the basal stalk of the entire aedeagus are densely beset with numerous acute black spines over much of the surface, as shown in Figures 4 and 5.

The aedeagus of *P. fusca* (Fig. 6) is quite different from that of the two preceding species, having only about six small spines of similar size and shape dispersed over its surface, without a trace of the two enlarged spines shared by *P. postrema, P. drakii,* and *P. ulkei*.

A closer similarity in both external features and paramere structure can be seen with *P. drakii,* to which specimens will be identified in the Luginbill & Painter (1953) key according to the degree of clypeal emargination. To examine a possible relationship (the two taxa appear to be largely allopatric), I prepared the aedeagus of a specimen of *P. drakii* from western Virginia, and present here a drawing (Fig. 7) that shows significant differences in the armature on comparison with the same parts in *P. postrema*.

The large terminal cluster of eight large, elongated, heavily sclerotized spines is noteworthy, but an additional feature of this species is a cluster of small spines, each arising from a sclerotized base, which collectively fuse into a placoid structure adjacent to the base of the proximodorsal spines (Fig. 7). Immediately adjacent on the ventral side are two small fields of very slender, almost setiform, denticles.

Phyllophaga latifrons (LeConte) Figure 8

The range of this species as shown by Luginbill & Painter (1935: Fig. 20) and later by Woodruff & Beck (1989: Fig. 544) shows a familiar pattern: North Carolina to Louisiana in the Atlantic Coastal Plain, with disjunction to New Jersey. The basis for the latter record is unknown to me, perhaps confirmation by recent collections is desirable (Robbins et al. 2006 did not capture it using pheromones at Chatsworth).

All of the North Carolina material in the NCSU collection is from several Coastal Plain counties; a record for Winston-Salem (Brimley, 1938) seems improbable. Harpootlian (2001) cites collections from seven counties in South Carolina, all below the Fall Line.

VIRGINIA: *City of Virginia Beach*: False Cape State Park, light trap at the Wash Woods Environmental Education Center, 6-7 July 2005, S. M. Roble (VMNH 10♂♂, 4♀♀). *City of Suffolk*: Holland, several dates in June and July 1945, James M. Grayson (VPISU 13♂♂).

Considering the size of the two samples cited above, it seems odd that the species has not been found at such well-collected localities as First Landing State Park, Savage Neck Dunes Natural Area Preserve, and Assateague Island, all of which have been subjected to assiduous trapping with black light throughout the apparent season of adult activity for this species.

Among the Virginia species of *Phyllophaga* this one is readily distinguished by several structural modifications in males. As illustrated by Woodruff & Beck (1989: Fig. 542) and Fig. 8 in this paper, the caudal edge of the 8th sternite is provided with two prominent paramedian uncate projections (in some of the local specimens an approach to four such processes is evident). The 7th sternum is deeply concave and overhung by the marginal hooks, and sterna 5 and 6 are medially concave. The straight or slightly arcuate margin of the clypeus is a useful aid in associating isolated females. The surface pruinosity is so pronounced as to impart a distinctive frosty gray color when illuminated from the correct angle.

The male genitalia represent an approach to the condition seen in *P. prununculina* in that the aedeagus is reduced in size and borne at the apex of an elongated cylinder, composed in part of the sclerotized and expanded distal ends of the baculum. Illustration and discussion of this structure are deferred for a later treatment of this general subject.

Phyllophaga prununculina (Burmeister) Figures 9-10.

This interesting species has been documented by Luginbill & Painter (1935) for a southeastern Coastal Plain distribution: North Carolina to Louisiana with a disjunct record for New Jersey. The absence of Virginia records has been, therefore, only fortuitous as the species is not uncommon in our Coastal Plain. VMNH material is from the following localities:

VIRGINIA: *Accomack County:* Assateague Island, Chincoteague National Wildlife Refuge, 3 July 1998, A. C. Chazal (1). *Northampton County:* Savage Neck Dunes Natural Area Preserve, Custis Pond, 17 July 2003,

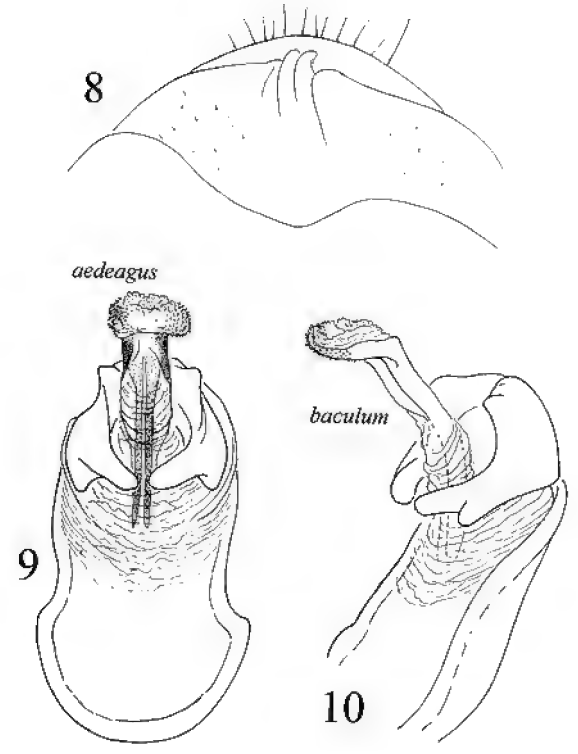


Fig. 8. *Phyllophaga latifrons* (LeConte). Sternum 8 of male, slightly oblique ventrolateral aspect, showing the two uncate median cusps. In true ventral aspect these are distinctly separated from each other and from the more lateral fold on each side. Figs. 9, 10. *Phyllophaga prununculina* (Burmeister). Fig. 9. Genitalia in ventral aspect, showing incorporation of baculum spicules distally into the sclerotized tube that supports the reduced aedeagus. In the other species discussed in this paper the baculum remains centered in the convexity of the apodeme when the aedeagus is everted. Fig. 10, Male genitalia with the baculum extruded, oblique lateral aspect.

Chazal & N. Van Alstine (2); 22 June 2004, Chazal & Field (1); 9 July 2004, Chazal (3). *City of Suffolk*: South Quay pine barrens, ca. 6 mi. south of Franklin, 20 June 2003, S. M. Roble (1); 5 August 2003, Roble (5). *City of Virginia Beach*: First Landing/Seashore State Park, 23 June-7 July 2003, Robert Vigneault (5). False Cape State Park, freshwater pond 0.3 km south Wash Woods Cemetery, 5 August 2005, Roble (32); main park road south of campground, 3 August 2005, Roble (1); main park road, 1.3 km south Wash Woods Cemetery, 4 August 2005, Roble (5).

Males of this species are easy to recognize by the combination of (1) lower metatibial spur vestigial or absent, (2) 8th sternum with an oval median depression bordered on each side by a setose protuberance, and (3) antennal club longer than stem. The parameres are also very distinctive, and in many specimens the baculum is fully extended. It is noteworthy that in this species, the true aedeagus is reduced to a small membranous cushion at the apex of the tube formed by coalescence of the expanded distal ends of the baculum spicules (Fig. 9).

There is little doubt that this beetle will be found at many additional localities in eastern Virginia. Its period of flight activity extends from late June to mid-August.

ACKNOWLEDGEMENTS

The Virginia Museum of Natural History continues to be under an obligation to Dr. Steven M. Roble (Division of Natural Heritage, Department of Conservation and Recreation) for providing the specimens reported here. Dr. Paul Lago, University of Mississippi, very kindly made or confirmed identifications. Robert L. Blinn made the North Carolina State University (NCSU) insect collection available, and Michael Kosztarab provided access to that at Virginia Polytechnic Institute & State University (VPISU). The anonymous peer review process brought to my attention publications, which I had overlooked, documenting the capture of *P. postrema* in New Jersey and *P. nitida* in West Virginia.

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Banisteria, Number 30, pages 32-34
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The Distribution of *Conoderus scissus* (Schaeffer) with Notes on Some Taxonomic Characters (Coleoptera: Elateridae: Agrypninae)

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ABSTRACT

The small click beetle *Conoderus scissus* has hitherto been perceived as being largely restricted to the Coastal Plain of extreme southeastern United States (South Carolina to Mississippi); its recent capture at two localities in eastern Virginia extends the known range about 675 km northward. Specimens preserved in regional collections reveal statewide occurrence in Georgia, and westward extension along the Gulf Coast into southern Mississippi. Dates of collection at peripheral localities imply successful migration within the past several decades. Detailed information on several taxonomic characters and a dot map of the currently-known distribution are given.

Key words: beetles, *Conoderus scissus*, distribution, Elateridae, southeastern United States.

Collections of click beetles recently received at the Virginia Museum of Natural History included a small, unfamiliar species of Agrypninae which, with Van Dyke's (1932) synopsis of *Conoderus*, was identified as *C. scissus* (Schaeffer, 1909). Since this species is documented only for a few localities between Mississippi and South Carolina, its discovery at two localities in coastal Virginia represents a northward extension of the known range of about 675 kilometers (420 miles).

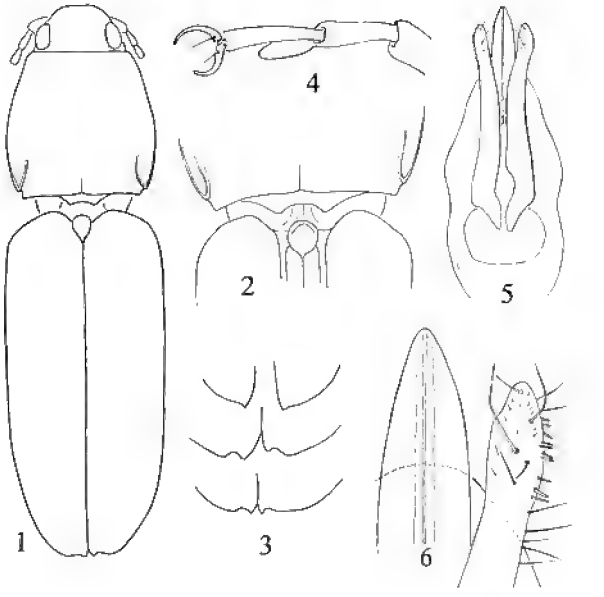
VIRGINIA: *Northampton Co.*: Savage Neck Dunes Natural Area Preserve, 23 June-28 July, 1999, A. C. Chazal and A. K. Foster (VMNH 3), also 28 July-27 August, 1999, A. K. Foster and S. M. Roble (VMNH 1). *City of Virginia Beach*: First Landing State Park, 23 June-6 July 2003, Robert Vigneault (VMNH 13).

Schaeffer's (1909) description of this beetle was based on specimens from Tybee Island, Georgia; Van Dyke's (1932) reference to it simply repeated that locality. Löding (1945) recorded *C. scissus* from Mobile, Alabama. Fattig (1951) collected the species at Savannah, Augusta, and Cornelia in Georgia, a nearly complete south-north transect of that state. Kirk (1970) provided records for Hilton Head, Hunting Island, and Edisto Beach, South Carolina, but he did not (1969) encounter *C. scissus* in his intensive collecting around Florence, just a few miles to the north of the three cited localities. Brimley (1938, 1942) had no records for North Carolina. Lago & Testa (1989) extended the range westward to Hancock Co., Mississippi. Peck & Thomas (1998) listed only Highlands, Lake, Lee, Marion, and Santa Rosa counties in their list of Florida beetles, in which the species' range was summarized simply as "FL-GA".

This rather sketchy history of the beetle motivated an inquiry into its possible inclusion in collections of more recent origin, with emphasis on the peripheral parts of the species' range. Although the North Carolina State University insect collection has extensive material of several other small species of *Conoderus*, not a single specimen of *C. scissus* from North Carolina is represented. The University of Georgia Natural History Museum (UGA) yielded a fairly extensive list of Georgia counties where it had been taken. Janet C. Ciegler provided a tabulation of South Carolinian *C. scissus* in her personal collection (JCC) that was far more extensive for the state than previously recorded by Kirk (1969, 1970). The National Museum of Natural History (USNM) provided a recent record for Wilmington, N.C., that narrowed the gap between South Carolina and Virginia. Lastly, I obtained records from the collections at Louisiana State University (LSU), the University of Mississippi (UM), and Mississippi State University (MSU). These data, as represented on the map (Fig. 7), produce a picture quite different from the one with which I started.

From the image of an insect nearly endemic to Florida, extending up the coast only as far as extreme southeastern South Carolina, the species is now known to occur far inland on the southern Piedmont, north on the Atlantic Coastal Plain to the Delmarva Peninsula, and westward into Louisiana.

The present pattern engenders several questions, the most immediate being "Where has the species been until recently?" It has not simply been overlooked by inadequate collecting: V. M. Kirk (1969) did not find it during his prolonged survey work around Florence, S. C., prior to 1969. P. W. Fattig (1951) had only three Georgia records despite many years of thorough collecting in that state; and the NCSU collection has extensive series of other species of *Conoderus* from eastern North Carolina. The earliest documented specimen of *C. scissus* from North Carolina (USNM specimen from Wilmington) was only caught in 1996, and the Virginia material not until 1999. There is an increasing body of information suggesting extensive northward migration by various insects during the past



Figs. 1-6. *Conoderus scissus* (Schaeffer). Fig. 1. Habitus sketch of body, dorsal aspect, appendages and surface features not indicated. Fig. 2. Base of prothorax and of elytra, enlarged to show shape of scutellum and prothoracic corners more precisely. Fig. 3. Elytral apices of three specimens from First Landing State Park, Virginia. Fig. 4. Distal metatarsal podomeres, showing size and narrow shape of tarsal lamella, usually not visible from above. Fig. 5. Male genitalia, showing general shape and position of parameres and aedeagus. Fig. 6. Apex of aedeagus and right paramere, greatly enlarged, to show appearance and placement of apical setae and lateral setules. The latter are apically rounded, thus not merely broken setae.

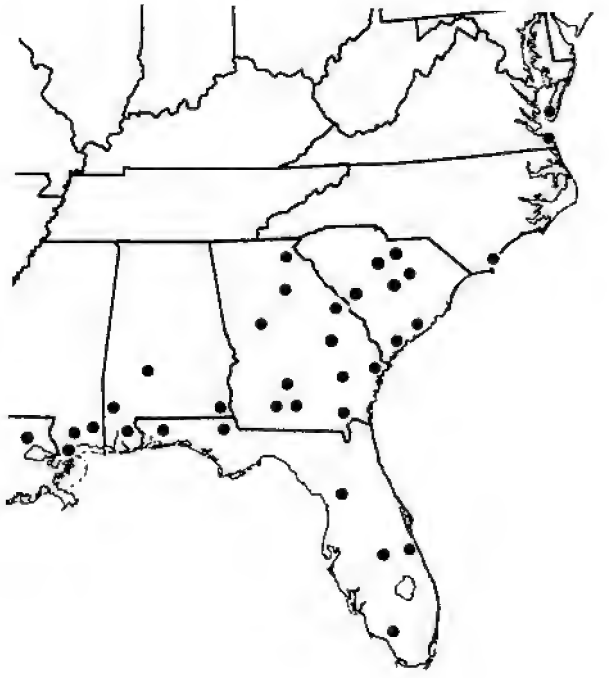


Fig. 7. Distribution of *Conoderus scissus*, based on published records and new data from museum collections.

50 years, and I venture the opinion that *C. scissus* may be among that number.

For an elaterid, *Conoderus scissus* is relatively easy to identify with confidence, being the only unicolorous member of its genus in southeastern United States having apically truncate-emarginate elytra and abbreviated posterior pronotal corners. I provide a sketch (Fig. 1) of a Virginia specimen to show the general habitus of the species. Our material agrees closely with the published descriptions except for some ambiguity about form of the elytral apices: Schaeffer (1909) wrote "apices sinuate near suture", Van Dyke (1932) expressed this profile as "elytral apices bidentate." Perhaps this is merely a subjective semantic difference: seen together the elytra do appear "bidentate". I illustrate this region to show (Fig. 3) variation evident in the Virginia series. Another character of possible specific value, the apically acute form of the scutellum (Fig. 2), has not been previously mentioned. In other Virginia species of *Conoderus*, the scutellum is bluntly rounded apically.

Schaeffer (1909) wrote "Fourth tarsal joint distinctly lobed but not quite so broadly as in *vespertinus*." In the Virginia specimens, the ventroapical lamella of the 4th tarsomere (Fig. 4) is actually ligulate in form, much narrower than in specimens of *Conoderus vespertinus* (Fabricius), in which it is distally truncate and broad enough to be

easily visible from above. It is uncertain whether Van Dyke actually had material of *C. scissus* or relied solely on the original description, since in his 1932 key, this species should conform to the second option in couplet 2: "Fourth tarsal segment with long and slender lamella beneath, the lamella not visible from above..." However, specimens do not agree with the other statements in that couplet, and even if the contradictions are disregarded and the option to couplet 17 is taken, will not match any of the three species to which that leads. Van Dyke's key would be improved by taking out *C. scissus* at a new couplet 2, distinguished by the abbreviated pronotal angles, acute scutellum, and incised elytral apices.

The male genitalia have not been illustrated for this beetle, a deficiency that I correct with the sketches provided (Figs. 5, 6). The outer distal edge of the parameres is provided with a series of tiny setules in the position normally occupied by setae.

ACKNOWLEDGEMENTS

I am indebted to several colleagues for providing relevant information or access to collections: Robert L. Blinn, North Carolina State University (NCSU); Janet C. Ciegler, Columbia, S.C. (JCC); Cecil L. Smith, University of Georgia Museum of Natural History (UGA), Terence L. Schiefer, Mississippi State University (MSU); Paul K. Lago, University of Mississippi (PKL), Christopher E. Carlton, Louisiana State University (LSU), and Warren E. Steiner, National Museum of Natural History (USNM).

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SHORTER CONTRIBUTIONS

Banisteria, Number 30, pages 35-36
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FIRST SPECIMEN RECORD OF GREAT WHITE HERON (*Ardea herodias occidentalis*) IN VIRGINIA--Reports of a Great White Heron (*Ardea herodias occidentalis*) near Fishers Hill, Shenandoah County, Virginia, began appearing on the Virginia Birding (VA-BIRD) listserve on 5 November 2006. In addition to these reports, a different bird was sighted during the same timeframe in Maryland at the Eastern Neck National Wildlife Refuge (Kent County) and spent about one month in the area (P. Davis, pers. comm.). The Great White Heron is currently considered a subspecies of the Great Blue Heron (*Ardea herodias*), and is typically restricted to coastal habitats of southern Florida (including the Keys), Cuba, the Isle of Pines, St. Thomas, Anegada, and formerly Jamaica (Butler, 1992). According to notes posted on the VA-BIRD listserve on 5 and 7 November 2006, local residents stated that the bird had been in the area for a "few months" and that it appeared "after the hurricane." Although Tropical Storm Ernesto was only briefly categorized as a hurricane, the National Weather Service (2006) reported the storm as tracking across the southern half of Florida before moving northward across the eastern third of North Carolina and Virginia (30 August to 2 September 2006) and is presumably the hurricane referred to by the local residents. Sightings of this Great White Heron (Fig. 1) were reported until near the end of November 2006. On 1 December 2006, one of us (C. Willis) contacted the National Museum of Natural History, Smithsonian Institution about donating a dead specimen of a Great White Heron that was found on 28 November 2006. Just prior to this, the dead bird was found in a culvert in Tumbling Run off Battlefield Road (Va. Rt. 601). The bird was buried for one day before it was salvaged. This is the first specimen record of a Great White Heron from Virginia (USNM 602093). The complete specimen record and photographs of the living bird (courtesy Rob Simpson) can be found on the Division of Birds searchable database (http://acsmith.si.edu/emuwebvzbirdsweb/pages/nmnh/vz/DtlQueryBirds.php). At the time of preparation, body mass was 1,972 g. with no body fat; Butler (1992) reported a weight range of 2.1 - 2.5 kg for this species. This bird did not appear emaciated and stomach contents included fresh vegetation, crayfish parts, and mammal hair. The male (testes = 9 x 3 mm) bird was all white, with bright yellow powder down patches. Reports on the listserve that the bird was struck by a car are consistent with the neck trauma found during specimen preparation.

Fig. 1. Great White Heron at Fishers Hill area in Shenandoah County, Virginia. November 2006 (photo: Rob Simpson).

Other sight records of the Great White Heron in Virginia include one from Daleville (Botetourt County) 1-4 June 1976 (Opengari, 1978). Three of single individuals were reported from South Holston Lake (Washington County), 15-16 October 1990 (Hall 1991), 29 August–12 September 1991 (Knight, 1992), and 25 August 1994 on the Virginia portion of the lake (Lewis, 1995). These three sightings possibly involved returning birds in at least some years (Iliff, 2003). Two, presumably different birds from South Holston Lake were reported 7-29 August 2002 and at Briery Creek Lake (Prince Edward County) 4 September–14 October 2002 (Iliff, 2003). Another bird was also sighted in Patrick County, 24-26 May 1997 (C. T. Kessler, pers. comm.), and photographed (by Jan Wiley) as it waded along a short stretch of the Smith River 0.75 miles southeast of the small community of Charity (Va. Rt. 704 and Rt. 40). Additional museum specimens of the Great White Heron should be collected when available to further document this species in Virginia.

ACKNOWLEDGMENTS

Rob Simpson provided the photograph of the living bird and suggested that the specimen be donated to the Smithsonian Institution. Ray Ritenour and James Allamong coordinated the transfer of the specimen to C. Willis. Claudia Angle provided advice on preparation and catalogued the specimen. Chan Robbins and Bruce Peterjohn (USGS) reviewed the manuscript and Phil Davis provided information about the 2006 Maryland sighting. We extend a special thanks to the Virginia birders who posted notes about this bird sighting, especially L. Friedman, C. Friend, S. Heath, J. and B. J. Little, and R. Simpson.

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Banisteria, Number 30, pages 36-37
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OBSERVATION OF EASTERN RED BATS (*LASIURUS BOREALIS*) MATING IN COASTAL VIRGINIA--At approximately 1515 h on 24 November 2006, Jethro Runco, Shannon Ehlers, and I observed an Eastern Red Bat (*Lasiurus borealis*) foraging over a brushy clearing along a road at Eastern Shore of Virginia National Wildlife Refuge (ESVNWR), which lies at the southeastern tip of the Delmarva Peninsula in Northampton County, Virginia (37° 06' N, 75° 57' W). The peninsula is a patchwork of agricultural areas, brushy fields, and loblolly pine woodlots. The first bat was joined by a conspecific at approximately 1530 h. The two bats began flying very closely together and we saw what we assumed was one bat suddenly drop and land heavily in the mown grass border along the road. We located the spot and found both bats on the ground in an obvious copulatory position. The male had mounted the female, ostensibly in flight, and was on her back, with both bats facing forward. The male gripped the dorsolateral fur of the female with the thumbs of his closed wings and was biting the fur on the female's back, as if to maintain his position; the female would occasionally turn her head back and chatter, but did not appear to make any attempt to disengage or escape. The bats were virtually oblivious to us as we held cameras a few cm from them and took several photos (Fig. 1) and short videos; at one point I even matted down a few blades of grass beside the bats with my foot without any apparent disturbance to them. The bats remained engaged for approximately 30 min; then, after a few sudden flaps of their wings, they disengaged, rested briefly on the ground, and flew away.

Published observations of mating Eastern Red Bats are rare (Stuewer, 1948; Jackson, 1961), and most breeding activity is believed to occur in August and September (Shump & Shump, 1982; Linzey, 1998). The date noted here is the latest reported; previous

Fig. 1. Male (left) and female Eastern Red Bats mating at Eastern Shore of Virginia National Wildlife Refuge, 24 November 2006 (photo: Scott McConnell).

"October" matings were noted by Allen (1869) and Saguey et al. (1998).

Bounded by the Atlantic Ocean and the Chesapeake Bay, the ESVNWR area is well-known as a bottleneck for migrating birds in autumn (Mabey & Watts, 2000). Eastern Red Bats are highly migratory (Shump & Shump, 1982) and likely concentrate in distribution along the Atlantic Coast during autumn migration (Cryan, 2003). It is possible that mating opportunities for Eastern Red Bats increase here as they gather in large numbers while waiting for optimal conditions to cross the Chesapeake Bay. Timm (1989) postulated that tree bats migrating through Chicago, Illinois, were concentrated along the shoreline of Lake Michigan due to their reluctance to cross the lake. As there are no overland routes to the south of ESVNWR, it is likely that Eastern Red Bats occurring in the area during autumn eventually cross open water on their southward migration. Carter (1950) reported *L. borealis* in a flock of about 200 bats seeking refuge on a ship approximately 100 km offshore of New York, and Thomas (1921) reported them in a flock that landed on a ship about 30 km off the coast of North Carolina. Allen (1923) suspected that this species was involved in a series of events in which bat flocks visited a ship off of the Atlantic Coast for three consecutive nights, including one night while the ship was in the Chesapeake Bay. All three of the events cited here of *L. borealis* over open waters off the East Coast occurred during autumn.

ACKNOWLEDGMENTS

Paul Cryan provided biological and editorial expertise in the preparation of this manuscript.

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Banisteria, Number 30, pages 38-39
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FIRST RECORDS OF THE RARELY COLLECTED BUG *NANNOCORIS ARENARIUS* FROM GEORGIA, NORTH CAROLINA, AND VIRGINIA (HETEROPTERA: SCHIZOPTERIDAE)

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On the basis of their paucity in collections, members of the family Schizopteridae may be considered among the rarest North American insects, with the majority of species known from fewer than twenty specimens. Only four species of this predominantly tropical and subtropical family have been recorded from the region north of Mexico (Henry, 1988). However, whether they are truly rare, or only rarely collected owing to their small size (typically <2 mm) or cryptic habits, remains to be determined. This family was unknown in Virginia until the recent reports of *Glyptocombus saltator* Heidemann by Roble & Hoffman (2000) and *Corixidea major* McAtee & Malloch by Hoffman et al. (2005). Herein, we add a third member of this family, *Nannocoris arenarius* Blatchley, to the Virginia fauna. The only other known North American member of this family, *Schizoptera bispina* McAtee & Malloch, has been reported from Florida, Mexico, and Guatemala (Henry, 1988), but it seems unlikely that this apparently more tropical species will be found as far north as Virginia in the future.

Nannocoris arenarius was described by Blatchley (1926) from Dunedin, Pinellas County, Florida. More than a half century later, both Slater & Baranowski (1978) and Henry (1988) reported that the species was still known only from Florida. Overlooked, however, was an obscure literature record for western South Carolina (DuRant & Fox, 1966). Below, we provide new or previously unpublished records of *N. arenarius* from Georgia, North Carolina, and Virginia. To facilitate recognition of this species, we provide a brief diagnosis and dorsal habitus drawing (Fig. 1) made (by RLH) from one of the Virginia specimens.

New records:

GEORGIA: Bryan Co.: no specific locality, 17 September 1974, R. Beshear, 1♀, "Berlese funnel on *Panicum*" (National Museum of Natural History [USNM]).

NORTH CAROLINA: Mecklenburg Co.: Davidson College, Davidson, berleseate of dried cattle manure, 11 November 1955, 5♂♂, Tom Daggy (North Carolina State University [NCSU]).

VIRGINIA: City of Suffolk: South Quay pine barrens, "100 m north of the canal" [36° 33.506' N, 76° 54.515' W], ca. 13 km S of Franklin, pitfall trap, 2 July-6 August 2003, 2♂♂, 1♀; 6 August-13 September 2003, 2♂♂, S. M. Roble (Virginia Museum of Natural History [VMNH]).

These records extend the range of *N. arenarius* about 600 km east-northeast of the nearest previously known locality, Clemson, in western South Carolina. Blatchley (1926) reported collection dates of 4 January to 16 February, and the USNM has two additional specimens that he collected at or near the type locality on 19 March 1927. All of the specimens reported herein were collected later in the year (July to November).

Diagnosis: Color uniformly brown, appendages and broad costal margin of hemelytra clear pale brown. Body length 1.1-1.2 mm, hemelytra strongly coleopteroid, without trace of membrane, veins prominent, costal margin broadly explanate. Head conical, prolonged anteriorly, eyes small, subpedunculate, overlying anterior corners of pronota, ocelli absent; antennae displaced ventrad below level of eyes, nearly in contact with rostral groove. Antennomeres 1 and 2 stout, cylindrical, similar in size and shape, 3 and 4 abruptly more slender, elongated, beset with long slender hairs, basal third of 4 notably broadened (Fig. 2). Rostrum extended back to level of mesocoxae, composed of 3 articles of which the 2nd is by far the longest. Bucculae absent, a shallow median

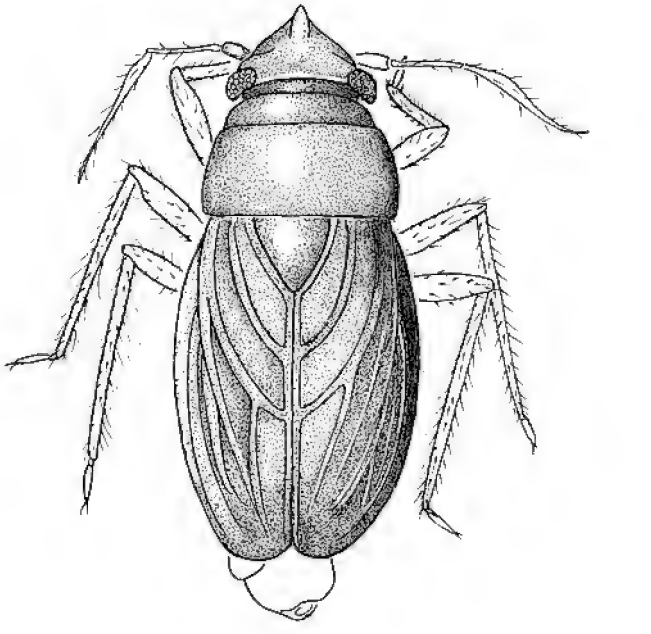

Fig 1. Dorsal aspect of *Nannocoris arenarius* Blatchley specimen from South Quay, Suffolk, Virginia. Details of wing venation cannot be shown precisely owing to the abrupt downward curvature of the hemelytra.

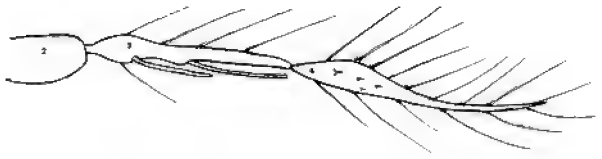

Fig. 2. Antenna of same specimen as in Fig. 1, showing modified setae of 3rd antennomere and broadened basal region of 4th.

rostral groove present. Anterior third of pronotum constricted, resembling a broad deep collar. Ventral sides of prothorax convexly enlarged around coxal articulation. Tarsi with two tarsomeres, the basal only 20% length of distal, latter slender-fusiform; tarsal claws simple, no arolia evident.

DISCUSSION

Until the genitalic structures of specimens from North American localities can be compared with that of the Neotropical type species, reference of our material to *Nannocoris* must remain somewhat provisional. A superficial comparison of the specimens from Davidson, N.C., with those from South Quay shows slight differences in antennal structure (same sex compared).

From the limited information at our disposal, it seems that this species is partial to dry biotopes. The original description (Blatchley, 1926) stated ". . . sifted from debris in the bases of dense tufts of grass growing on the middle ridge and sides of an otherwise bare sandy roadway through the pinelands." Specimens from Clemson, S.C., were taken in rocky, sandy soil in pine stands (none from hardwood stands; DuRant & Fox, 1966). The series from Davidson, N.C., were noted as being extracted from the material beneath dry "cow patties," and those from South Quay were taken in pitfalls in xeric pine woods. The species was not attracted to UV lights operated nearby on numerous occasions.

Although DuRant & Fox (1966) specified that their insect material was identified by specialists with the Agricultural Service, USDA, no specimens of *Nannocoris* were apparently retained for the USNM collection, nor did Dr. A. G. Wheeler find any in the logical depository at Clemson University. The whereabouts of these specimens remain a mystery.

ACKNOWLEDGEMENTS

We are grateful to Robert L. Blinn for access to specimens housed in the NCSU collection and A. G. Wheeler, Jr. for confirming the absence of specimens from the Clemson University insect collection. M. G. Pogue (Systematic Entomology Laboratory [SEL], ARS, USDA, c/o National Museum of Natural History, Washington, DC), A. G. Wheeler, Jr., and N. E. Woodley (SEL) kindly reviewed the manuscript.

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Banisteria, Number 30, pages 40-41
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APPALEPTONETA COMA (BARROWS), A SPIDER NEW TO VIRGINIA (ARANEAE, LEPTONETIDAE) -- The spider family Leptonetidae includes small, fragile, long-legged spiders inhabiting leaf litter and caves. Except for a single eyeless one from a Georgia cave, the species in eastern North America may be easily recognized by their unique eye arrangement: a short arc of four close-set eyes in front, and a single pair far back on the carapace (Ledford et al., 2005). In North America, four genera have been recognized: *Archoleptoneta* Gertsch 1974 (see also Platnick, 1994), *Neoleptoneta* Brignoli 1972 (see also Cokendolpher, 2004), *Calileptoneta* Platnick 1986 (revised by Ledford, 2004), and *Appaleptoneta* Platnick 1986. *Appaleptoneta* includes fifteen described species ranging through the southern Appalachians from southern West Virginia to northern Alabama. The known species were described and illustrated (as species of *Leptoneta*) by Gertsch (1974); later, seven of Gertsch's *Leptoneta* species were placed in the new genus *Appaleptoneta* by Platnick (1986). The genus was established largely on the unique form of the cuticular plates surrounding glands on the patellae of the legs; these can only be studied in detail using scanning electron microscopy. Ledford (2004) found significant diversity, even within single species, in the gland plates of *Calileptoneta;* the glands occur not only on the patellae but the femora and tibiae as well. A single Appalachian species, "*Leptoneta*" *sandra* Gertsch 1974*,* is *incertae sedis* due to the unique form of the patellar plates (Platnick, 1986), but otherwise closely resembles *Appaleptoneta* species. Based on Ledford's (2004) results, the unusual form of the plates might not disqualify this species from being part of *Appaleptoneta*.

As is well known among students of arachnid and myriapod systematics, cave habitats have been far more thoroughly collected than the soil and litter biotope, where many of the same taxa as those inhabiting caves may be found. Only five of the fifteen eastern North American leptonetid species were collected on the surface; the remaining ten are known from single collections made in single caves.

Two surface-dwelling leptonetid species have been recorded previously from Virginia. "*Leptoneta*" *sandra* has already been alluded to; in 1971, my student, Sandra Bird Porterfield, and I collected many specimens from leaf litter on both the northwestern (Mercer Co., West Virginia) and southeastern (Tazewell Co., Virginia) slopes of East River Mountain, some of which were the basis for Gertsch's (1974) later description. Mrs. Porterfield collected material through a year and produced an unpublished study on the species' life cycle. No further records have been published in the intervening 33 years. *Appaleptoneta silvicultrix* (Crosby & Bishop) 1925 was the second species of leptonetid to be described from North America, and the first species from the East. It is known from a number of localities in western North Carolina and from a single collection I made in Cumberland Gap National Park, Lee Co., Virginia (Gertsch, 1974).

Appaleptoneta coma (Barrows) 1940 was described from a single sample obtained near Gatlinburg, Tennessee, and has not been found again from 1936 (Gertsch, 1974) until 2007. The species is easily recognized by the unique row of long setae on the bulb of the male palpus. The new record is as follows:

VIRGINIA: *Washington County*: Mount Rogers National Recreation Area, Beartree Division, Beaver Flats Campground, 23 May 2007, W. A. Shear leg. 3♂♂, 1♀.

The specimens, which will be deposited in the Virginia Museum of Natural History, were taken from a sample of leaf litter dominated by hemlock, birch, and maple leaves and underlain by a deep layer of duff. The general habitat is a broad, flat, forested area braided with small streams and with scattered small ponds and wetlands; the forest may be secondary but many of the hemlocks are large enough to suggest that elements of a primary forest still remain. The sample was transported to Hampden-Sydney and animals were extracted by means of Berlese funnels. Surface-dwelling leptonetids are difficult to collect because of their habitat, small size, and delicacy; Berlese extraction seems to be the most effective way to find them, and undoubtedly more complete sampling through the Appalachian region would show them to be much more common than current data indicate. The appearance of both *A. silvicultrix* and *A. coma* in Virginia, both in places distant from other published localities, suggests that species of the genus might be widespread.

Because the drawings by Gertsch (1974) were made using low magnification, many details of the surprisingly complex male palpus were not depicted, though the illustrations are sufficient to identify the species. Ledford (2004) found that females of *Calileptoneta* could not be diagnosed using Gertsch's drawings, and Cokendolpher (2004) concurred for *Neoleptoneta*. Ledford used both compound microscopy and scanning electron microscopy to study the palpi and provided a terminology for the various parts. A revision of *Appaleptoneta*, involving extensive new collecting, is very desirable; if females cannot be diagnosed on the basis of Gertsch's (1974) revision, it

will be especially important to collect males at the type localities of those *Appaleptoneta* species based only on females.

ACKNOWLEDGEMENTS

I thank Dr. Fred Coyle for organizing the field trip on which these specimens were taken.

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Banisteria, Number 30, pages 41-43
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CHINESE SOFTSHELL TURTLE (*PELODISCUS SINENSIS*) IN THE POTOMAC RIVER AND NOTES ON EASTERN SPINY SOFTSHELLS (*APALONE SPINIFERA*) IN NORTHERN VIRGINIA -- Two recent observations of softshell turtles from the Potomac and Occoquan rivers, Fairfax County, Virginia, indicate that this group of vertebrates may have been introduced into northern Virginia. One is an Asian species, whereas the other is North American, but not native to northern Virginia.

On 3 August 2006, a *Pelodiscus sinensis* (Chinese Softshell; Fig. 1) was observed on a low sloping, sand and gravel bank in a bay of the Potomac River at Dyke Marsh along the Haul Road in Fairfax County (77° 03' 0.48" W, 38° 46' 25.57" N). It disappeared into nearby grassy cover upon closer approach by the observer, after being photographed. On 21 July 2007, a fisherman caught a juvenile female *Apalone spinifera* (Fig. 2) in the Occoquan River (Fairfax County/Prince William County line) near the marina approximately 9 km from its confluence with the Potomac (77° 15' 03.38" W, 38° 40' 38.21" N). The turtle was brought to the nature center at Fountain Head Regional Park. Additional, unverified sightings of *A. spinifera* by boaters in this area were reported to Ben Fleming, park naturalist, after the first one was captured (B. Fleming, pers. comm.). The Occoquan River site is well outside of the natural range of this species in southwestern Virginia (Mitchell & Reay, 1999).

The closest known population of Eastern Spiny Softshells, also an introduced population, is in southern New Jersey in the Maurice River system (Conant & Collins, 1991). Mansueti & Wallace (1960) reported on an attempt to establish this species in the Potomac River below the dam at Cumberland, Maryland, in 1883. Harris (2004) noted recently that the status of a putative population in the canal below Great Falls on the Potomac River, Montgomery County, Maryland, is unknown, as is the fate of the 1883 introduction.

In Virginia, *Apalone spinifera spinifera* is native only to the Clinch and Holston river drainages in the southwestern portion of the Commonwealth (Mitchell, 1994; Mitchell & Reay, 1999). The species is listed in Virginia as status undetermined and of moderate conservation need (Mitchell, 1991; VA Dept. Game & Inland Fisheries http://www.bewildvirginia.org/species/reptiles.pdf, accessed 24 December 2007). Introductions have been reported from Bull Run Creek (an Occoquan tributary), Fairfax County, in 1982 (Mitchell, 1994) and in Lake Whitehurst in the City of Norfolk (Mitchell & Southwick, 1993).

Fig. 1. Chinese Softshell (*Pelodiscus sinensis*) at Dyke Marsh, Potomac River, 3 August 2006 (Photos: Ed Eder).

The turtles observed in the Potomac and Occoquan rivers may have been released from an Oriental food market in northern Virginia or Washington, DC. Such markets routinely sell turtles despite federal and state regulations. On 8 December 2007, one of us (PPvD) observed 7 live *Pelodiscus sinensis* offered for sale in the fresh fish/seafood section of a supermarket in Merrifield, Fairfax County, Virginia, which caters mainly to Oriental communities. These turtles showed standard Asian farm-product morphology, size (ca. 12-15 cm carapace length), and weight (ca. 1 US lb.). They were advertised at US $11.99 per pound. The adjacent tank contained American Bullfrogs (*Rana catesbeiana*, apparently from an Asian farm), Yellow/swamp Eels (*Fluta alba*), and White Eels (*Anguilla* sp.), all of which represent potential invasives. Perhaps well-meaning people have purchased turtles in the markets to prevent their presumed slaughter and released them in nearby rivers. A case in point is the purchase of animals, including turtles, from an Oriental food market in New York and their release into the Passaic River, New Jersey, by people concerned about their welfare (Anonymous, 2007).

Harris (2004) reported on an uncatalogued specimen of *P. sinensis* in the collection of the Natural History Society of Maryland that was found dead on 8 December 2003 along the Potomac River at National Colonial Farms Museum, Accokeek, Prince Georges County, Maryland. This location is 21 km downstream from the Dyke Marsh site. Thus, this introduced Asian softshell has apparently been released and perhaps present in the Potomac River for at least 3 years.

Judging from the available photographs, the Chinese Softshell observed at Dyke Marsh does not exhibit every feature characteristic of the standard farmed version derived mainly from Taiwanese stock, but partly resembles a North Vietnamese/South Chinese animal in its possession of pigmented rosettes on the carapace.

Fig. 2. *Apalone spinifera* from the Occoquan River, 21 July 2007 (Photos: Benjamin Fleming).

Could the way in which these turtles were shipped to the United States reveal how the Northern Snakehead fish (*Channa argus*), which occurs in the same region in Asia (http://www.invasivespeciesinfo.gov/aquatics/snakehead.shtml, accessed 10 December 2007), entered into Maryland and Virginia streams (Orrell & Weigt, 2005)? And could it be indicative of a large-scale illegal import of Asian species for the Asian food markets in the mid-Atlantic region? The introduction of an Asian turtle into Virginia waters via commercial food market routes suggests that other introduced species may be discovered in Virginia and Maryland in the future, especially if they are able to tolerate temperate zone climates like *P. sinensis* can. *Pelodiscus sinensis* is listed as Vulnerable in its native range (http://www.iucnredlist.org/, accessed 16 December 2007).

Such periodic intentional or unintentional releases may result in the establishment of softshell turtle populations in the Potomac and Occoquan rivers. Multiple releases of *P. sinensis* increase the probability that a reproducing population has been or is likely to become established in the Potomac River. Additional data are needed to determine whether individuals are reproducing. Observations of nesting females and hatchlings would confirm establishment of breeding populations.

ACKNOWLEDGMENTS

We thank Ed Eder and Benjamin Fleming for bringing these observations to our attention and for providing photographs.

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MISCELLANEA

LAND UNVANQUISHED[1]
PARTS IX-XVI

Roger H. de Rageot

PART IX.
SNAKE COUNTRY

Also prominent among the animals of the great Tidewater coastal swamps is the large reptilian tribe, cold-blooded creatures who crawl, swim and lumber through this dimly lighted region. Here we have the vast snake tribe, and we cannot help feeling a chill run down our spines whenever we visualize the members of this crawly bunch in action.

First of all are the pit vipers, so called because of a small hole situated between the eye and the nostril; this hole, or pit, is richly supplied with sensory nerves, a device enabling the snake to locate its warm-blooded prey in darkness. Among the pit vipers are some of our most fearsome snakes, the Eastern Diamondback Rattlesnake, an ominously impressive species sometimes attaining a length of eight feet; the Canebrake Rattlesnake, reaching a record length in excess of six-and-a-half feet; the Eastern Cottonmouth, a large snake, gregarious on water banks, and the Copperhead, who is, at the most, four-and-one-half feet long and is the least dangerous of the pit vipers.

Then, of course, there are water snakes such as the above-named Cottonmouth, preferring a semiaquatic existence along water banks, capturing fish, frogs and other prey dwelling in their own aquatic environment.

There is the Brown Water Snake, a dark brown in color, with square, dark blotches; the Banded Water Snake, whose coloration is an intricate alternation of light-and-dark bands; and the Red-Bellied Water Snake, muddy brown above, and a deep orange on the underpart of its body.

Because of a similarity in color patterns, environment and habits, the harmless Brown and Banded Water Snakes are often difficult to distinguish by the amateur herpetologist from the very dangerous Cottonmouth Moccasin; however, the triangular head, elliptical pupils and heavy body of the pit viper should immediately form certain reliable characteristics for distinction in the field.

Certainly the most handsome are the Eastern King Snakes, shiny black-clad, with large, bold links of creamy white; and the Corn Snake, a beautiful red or orange serpent, with darker blotches. The diet of the King Snake consists of other snakes, as well as snake and turtle eggs, while that of the Corn Snake is mostly rodents. Both are powerful constrictors, and the King Snake when annoyed will attack and overpower serpents larger than itself.

South of Albermarle Sound, in Tyrell and Hyde counties, in North Carolina, is one of the largest and wildest stretches of open swamp on the Atlantic coast. One can drive for miles in places there along the highway without encountering a single house; indeed, I have known many to stop their automobiles in the center of one such place, and after having stood in the middle of the empty highway running through this forbidding wilderness, to exclaim aloud: "This is one of the most desolate spots I've ever seen!"

The physical aspects of this place are odd, even unique: the abundant vegetation below is an alternation of thick bushes, ferns and canes, with black pools and canals; above this thick and deep green vegetation stand short pines and many dead trees; these dead trees are numerous enough to form what I would call "A dead forest." The dark green of the living vegetation contrasts so deeply with the light color of the dead pines and cypresses standing above it that they appear a whitish-gray by contrast, making this region quite picturesque indeed; the fact that Black Vultures often stand immobile like sentinels at the summits of these dead trees, gives an additional note of color to this place. In the lower, more open places, "Great

[1]Editors' Note: This completes the manuscript entitled Land Unvanquished; background information and parts I-VIII were published in *Banisteria* Number 29.

Trumpets," or *Sarracenia flava*, a member of the insectivorous pitcher plant family, grow in great abundance; I know of no other place where they grow in such big numbers. In early April, their large, yellow flowers delicately tinted with green, remind one of large, yellow tulips, adding their own original note of color tonality to this strange land. One can readily imagine the particular beauty of the scene by the juxtaposition of plants, trees and birds: there are the yellow, tulip-like blossoms of the Great Trumpets, the dark green vegetation above the whitish-gray, dead trees; and topping it all, the stately, Black Vultures perched atop these dead trees. When viewed on a clear, moonlight night, this region appears particularly eerie.

This Tyrell and Hyde counties region, "Ninety-Four," as it is known by those who have been introduced to it, because Ninety-Four is the number of the U.S. Highway crossing most of it, is one of the richest snake regions in the whole United States. Here reptiles seem to grow larger and are more numerous both in the number of individuals and in their species, than in any other single region of its size. Here we also find our largest Southern Copperhead, measuring forty-two inches in length, likewise our largest Pygmy Rattlers; indeed those pygmies we met in Hyde County were almost too big to be called pygmies. Besides its largeness, another peculiarity of the Pygmy in this region is its coloration: reddish is the ground color in the northern part of the range, while light lavender predominates in its more southern ranges. Most of these observations were made by a Mr. William M. Palmer, great Southern Coastal Plain herpetologist from the North Carolina State Museum at Raleigh, who also believes that the Southern Pygmy is a distinct subspecies from its Northern counterpart. Only one Pygmy has ever been found on the Virginia side of the North Carolina State Line; this immature species was discovered in the Northwest River part of the Dismal Swamp on November 4, 1937, and it bears the reddish ground coloration of the Northern range.

Several species of reptiles and amphibians are found in Hyde and Tyrell counties, south of the Dismal Swamp, which are not encountered in the swamp itself: one, the Eastern Diamondback Rattlesnake, has been reported from both Tyrell and Hyde counties; however, this species must be very rare in this northernmost limit, for we have never met it there during any of our many collecting trips.

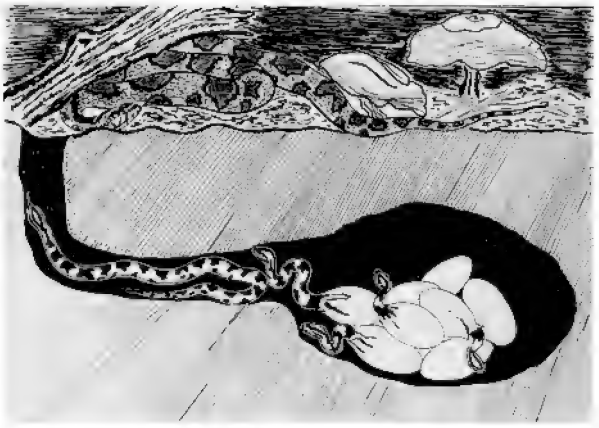
Alligators are also to be found in limited numbers in the swamps bordering the Alligator River; once, I personally discovered an Alligator skeleton there.

Here also is found our smallest true toad, the Oak Toad, whose peeping somehow reminds one of a baby chick; and the Little Grass Frog, smallest of the world's small vertebrates, with a total length of from 5/8 to 7/16 of an inch; this little frog was long classified with the chorus frogs in the genus *Pseudacris*, but now that the genus has been revised, it is believed to be a tree frog and is so classified among them in the genus *Hyla*[2]; if it is a tree frog, it is certainly a primitive one, because its suction pads when contrasted with other tree frogs are not well developed.

The Black Swamp Snake, a small species from ten-to-fifteen inches in total length, shiny black above, with a brilliant orange-red belly, also finds its northern limits in Tyrell and Hyde counties; the Glossy Water Snake, fourteen to twenty-four inches in total length, a definitely aquatic species, whose diet, there is reason to believe, consists mostly of crayfish, and whose best field marks are two distinctly parallel rows of black dots down its belly, and which is so secretive in habit that much more data is needed before it becomes well known; and finally, the handsome Corn Snake. The reason that most of these species do not occur in the Dismal Swamp must be answered by the fact that the presence of such a large body of water as the Albemarle Sound presents a formidable barrier to some of these animals.

In Tyrell County, on a small dirt road at the edge of the forest, is a huge sawdust pile; for years, Corn Snakes have come here to deposit their egg clutches. In early June, the female will deposit her eight or fourteen eggs, maybe in an old Bank Swallow hole near the summit of the sawdust pile, or in some fissure, or in an old toad's burrow, in a round chamber properly provided by the female. Here, the sun's warmth against the sawdust pile itself forms a natural incubator, and the tough but pliable shell shortly shows bulges, as the embryo grows within; by the middle of August, the snakelets pierce this egg envelope. As many as four or five female Corn Snakes will often congregate for a communal egg laying, depositing their clutches of from eight to fourteen eggs close together. On several occasions, I have witnessed this event; one instance, however, I particularly recall: this was on August 18, 1956, at the old sawdust pile in Tyrell County. It was a day of oppressive heat with the humidity and Yellow Flies at their worst. I was digging in the sawdust, following a small hole, when suddenly I began to find clutches of eggs and young Corn Snakes, all close together, separated only by the wall pockets, each one

[2]The Little Grass Frog has since been returned to the genus *Pseudacris* (see appendix of scientific names).



of which contained an egg clutch, or a bunch of newly-hatched Corn Snakes. During the next few minutes, I did nothing else but dig out eggs and young snakelets until the whole place was literally crawling with them; I counted approximately thirty snakelets and forty eggs!

If you have never been on a collecting trip with a group of herpetologists, both amateurs and professionals, it is definitely something you should do at least once in your lifetime, as it will be an experience you will find both exciting and rewarding; allow me to briefly recount to you here such a snake-hunting trip: the sun was yet high when we reached Highway Ninety-Four, and as our old jalopy chugged along at moderate speed, we could see this strange and desolate landscape rolling by; we could also see the long canal on the right side of the highway with a group of large pseudemid turtles, mostly Yellow-Bellied, often piled on top of one another, basking in the late afternoon warmth. Occasionally, we could see one or two Red-Bellied, a solitary snapper, or again, a Spotted, or Mud Turtle. North America is quite fortunate in having a rich fauna of this interesting reptilian group which were contemporaries of the dinosaurs and have not changed since then. As they lay dozing on a floating log, the Yellow-Bellied group formed a rather interesting composition. They sleep quite lightly, however, and their sense of hearing is exceedingly acute; let one approach the water, and at the slightest sound, they will raise their scrawny, colorfully striped necks in alarm, and with a scraping of carapaces, they will plunge into the inky water with an audible splash.

We sped onward, William Palmer, two young, enthusiastic herpetologists and I. Suddenly, shouts came from the back seat; an area by the edge of the road containing a few logs, bark and some rubbish, was sighted; we quickly brought the automobile to a halt and everyone piled out, snake sticks and all. Bark was turned over, decayed logs split open and broken to pieces. From time to time, a Southern Ring-necked Snake, a Red-Bellied Snake, a Rough Earth Snake and a serpentine imitation of the earthworm, completely adapted to a life of burrowing, were uncovered from the dank, dark recesses of their respective habitats. All of these diminutive members of the serpentine group, which are of no interest to the general public and whose very existence is generally ignored, are often interesting creatures with unique habits and adaptations.

More bark was torn from tree trunks, more logs demolished, until it looked as though a band of Wild Hogs had been digging away at the ground, logs and stumps, searching for food. The snake tribe probably thought doomsday had arrived. Lucky indeed were those who escaped the overflowing zeal of our young naturalists. We stopped many more times and began to tear away at bark and logs and to dig into the forest floor. The number of reptiles in our collection mounted. Once we heard the excited call of "Black Swamp Snake!" Before one of our young naturalists could snatch it, we all rushed together to see for ourselves this little, black, shiny snake, with its bright orange belly, twisting on a split open log; so far, this was our prize catch of the day, and the third recorded of this species in its northernmost range.

The sun, a golden disc, slowly descended behind the trees, standing in dark silhouettes against the sulphur-colored sky. Night came, and with it, the call of the Chuck-Will's Widow. Now the real collecting would begin by headlights: we began driving very slowly up and down Highway Ninety-Four, and other country roads, with the high beam of our headlights on. Two of us took turns sitting on each of the front fenders, keeping our eyes peeled for reptiles along the edges of the road.

It is a well-known fact that both reptiles and amphibians love to cross tar-surfaced highways at night, especially after a warm, Summer rain: nobody knows the exact reason for it, but since they seem to prefer tar surfaces, it is highly probable that heat is retained in such surfaces. As a direct result of such a practice, both reptiles and amphibians are a number one casualty to night highway motor traffic.

From time to time, someone would shout, "Snake ho!" The jalopy was halted as quickly as possible, and everyone would leap out with flashlights, snake bags, hooks and other collecting paraphernalia. Sometimes it was a Cottonmouth, a Copperhead, a Mud Snake, or a Red-Bellied Water Snake; on two such occasions, a pair of beautiful, adult Corn Snakes were captured. It often happened that the automobile was not brought to a halt quickly enough, and we had to back up for a considerable distance; then we were very lucky if the

snake hadn't disappeared into the weeds before our arrival. Once in a while the headlights would pick up the amber eyes of wild animals by the roadside; we could see them dancing in the tall grass just before they took off for the forest. Once we saw a young Bobcat with arched back, standing on a fungied log for a few seconds before he bounced away into the darkness of the thick brush.

Night collecting also has its disappointments: we made many useless stops for such things as an old discarded fanbelt, an old piece of rag, a chuck of rubble, a stick, or a simple branch; our names for these were "Fanbelt snake," "Rag snake," etc.

Once we had the extreme pleasure of coming upon a large Pigmy Rattlesnake: again everyone piled out of the car while advice was shouted in the darkness; "Careful, don't get bitten now!" or "Let me handle this one, I've had more experience!" During this time, the snake, blinded by all of those lights in his eyes, lay coiled up on the roadway, mouth open, fangs bared and ready to strike until its head was firmly pinned against the tar surface of the road, and it was quickly grabbed by its neck, just back of its head, and thrown into an open collecting bag. Then the whole happy crew of herpetologists would climb back into the broken-down jalopy and drive on down the road, singing and cracking jokes until their next encounter. It was certainly a lucky trip and the reptiles were plentiful.

Now we came close to great Lake Mattamuskeet, located at the end of Highway Ninety-Four, a haven for ducks, Whistling Swans, Snows and Canada Geese. Around a half mile from the lake itself, a long, coiled snake, smack in the middle of the highway, was reflected in our headlights; this time it was a seventy-inch-long, greenish Rat Snake. It was an interesting discovery because this curious variation is peculiar to this region. Rat snakes, genus *Elaphe*, comprise the Corn Snake, the Yellow Rat Snake and the Black Rat Snake; all are excellent climbers and all prey extensively on small rodents.

It was nearly three o'clock in the morning. Monotonous drones of katydids filled the air. A thick mist hung over the lake. By this time, we were somewhat exhausted, so it was decided that we should camp by the lake shore. Blankets and sleeping bags were brought out, and each one selected a spot and stretched out. A fairly strong breeze was blowing, so we counted on it to keep the mosquitoes away. I don't know how long I slept, but I suddenly awoke with an unpleasant sensation and with big welts all over my arms and face. The breeze had died down, and myriads of mosquitoes had descended upon us. I made a beeline for the car, rolled up all of the windows and stretched out; I was soon joined by another camper; the others stated they were brave enough to withstand the attack. Nothing is more accursed or unpleasant than a mosquito; simply to hear one buzzing nearby is enough to cause me to scratch.

The next morning, we were indeed a ragged bunch of herpetologists as we departed for the Pine Barrens of Morehead City, in North Carolina. As we left, great, tall, Blue Herons on long legs were fishing by the shores of the big lake. A gentle breeze was softly whistling through the Long-Leafed Pines, and the high-pitched trills of the Indigo Buntings fiercely arose from the shrubbery.

We finally did arrive in the Pine Barren area of Morehead City. The landscape here was mostly composed of Long-leafed Pines, the enormous cones of which littered the ground; there was also some heavy grass and bushes, mixed with open, sandy spots. The first signs of reptilian life in the immediate vicinity were the tracks of a Six-lined Racerunner, who left imprints of his tiny feet and tail on the sand. We spent most of the first day collecting but found very little; but what we did find, however, was of interest: we managed to locate one Scarlet Snake, a small banded red-and-white species, with a pointed snout, usually found in or near soil suitable for burrowing; it was a species generally hard to find, therefore much sought after by collectors, and a Crowned Snake: the Crowned Snake, the smallest species in the Great Swamps, is usually from eight-to-ten inches long, possessing poison glands and tiny, grooved fangs in the rear of its jaws. Since its minute teeth can scarcely puncture human skin, its venom is only effective on insects. Just as we were about to leave, I happened to turn over a small log near a bog, and coiled under it was a large Yellow-lipped Snake at least eleven inches long; due to its secretive habits, this species is a fairly rare one among collectors, and I was elated to find it. We decided to call it a day.

One should visit these Pine Barrens in early Spring, when the sweet-scented Vernal Irises thrust forth their blooms; I don't believe there is anywhere a wild flower so attractive and delicate: its petals are blue, faintly tinted with violet and purple, with a golden heart. At this time, its grass-like leaves had not yet matured and were mere buds, so that the flower alone stood on its short stalk, sharply contrasting with its background of white sand, or a rustic carpet of leaves.

So we did finally take our reluctant leave in the crepuscule, just as the Hoary Bats began their swift, erratic flights above the trees.

PART X.
FOREST COMBAT

In the Great Dismal Swamp of Virginia, as elsewhere in nature, the strong rule the weak; so the Scarlet King Snake wages a relentless war upon lizards, his main food item.

Deep inside the dark swamp, just before the flaming, Summer sun finally disappeared for the day, he saw the last ephemeral display of brilliant colors in the western horizon. He slid slowly out from under the bark of an old log where he hid during the day. In the fast gathering dusk, lightning bugs glittered and shadows under the big trees deepened. The night air entering his lungs gave the Scarlet King Snake a sense of euphoria. During the early morning hours and also in the late afternoon, he had grown accustomed to lazily stretching out on an old log; under the sun's warmth, he lay in a condition of semi-torpor; the sun's rays felt very good on his slim body. As the brisk night air sharpened his instincts, however, he grew restless, for he was primarily a night hunter.

Four days ago he had dined on a Broad-Headed Skink, two days of which had been spent digesting his unlucky victim; now the sharp pangs of hunger assailed him, and he truly realized that there would be no rest for him until this basic craving, presently gnawing at his vitals, was completely satisfied. Thus urged on, he silently glided through the fallen branches matting the forest floor. Now and then, he would flick out his forked tongue, feeling every strange object he met: this tongue of his was like a delicate and highly sensitive hand; it was also a hypersensitive olfactory nerve, keeping the snake in absolute contact with his surroundings.

He passed through a certain clearing where the toads were known to hold musical concerts characterized by those high-pitched, tremulous tones of theirs and came to the base of a large pine tree. Deep in a cavity behind the pine bark, an old lizard peacefully slumbered. The Scarlet King Snake came quite close to the old lizard's hiding place. He could even feel the nearness of the lizard, and his tongue flicked frantically, informing him of the lizard's exact position. He slowly and stealthily crawled into the cavity where the lizard slept; then his body coiled upon itself like a steel spring, with every muscle tense; during all this time, the lizard had not even awakened. The Scarlet King Snake suddenly uncoiled with the speed of lightning, and his wide-open jaws tightly fastened in the middle of the lizard's body; a violent struggle at once ensued, and these two adversaries came out into the open, furiously rolling over and over each other. With time's passage, the battle seemed to be both heedless and exhaustless, their identities being lost in a mad flurry of wiggling bodies. Only death itself could separate them now.

The old lizard, after several vain attempts, finally seized the body of the snake in his own powerful jaws; the Scarlet King Snake felt a mounting pain coursing through his great length, but this pain only served to further aggravate his terrible combat fury: he began to wrap his powerful body of constriction about the lizard; the lizard relaxed for a brief moment, losing his grip on the snake; the snake immediately seized this golden opportunity, and his jaws took a firm hold on the lizard's head.

As he thrashed madly about, the death terror arose instantly within the lizard; but the needle-sharp teeth of the snake, all of which curved inward, made it absolutely impossible for the lizard to break free.

The mortal combat was closing; the lizard was weakening. The loosely articulated and much more movable bones of the snake's head had stretched to accommodate the passage of its prey, and already, half of the lizard's body had disappeared into the snake. As he expired in his death throes, a few jerks coursed through the lizard's body.

As the monotonous drone of the Tree Crickets rang out in the forest, the Scarlet King Snake had, by now, completely swallowed his victim; and as he moved back to his secret retreat, he could already feel the sluggishness of digestion overtaking him. Part of the unfortunate lizard's tail still hung from his mouth.

An Opossum moved in the darkness. Evening Bats were squeaking in the somber sky.

PART XI.
LOST IN THE WILDERNESS

The man was but a casual visitor in the great swamp, and his mind was so busy with those rather meticulous details of nature, he completely overlooked certain reference points which he would later on need to ascertain such a thing as his own geographical location; indeed, he was oblivious to all things save those oft-curious ways of natural history; such as, for instance, the fact that the Sweet Bay Magnolias, which had earlier spread their leaves, were now in full bloom; he noted how their strong fragrance soared skyward. The invisible Wilson's Warblers were singing through the inattentive wilderness.

At the highway's edge, he saw three Ruby-Throat Hummingbirds hovering among the Trumpet Vines,

pausing here and there in mid-air to gather the nectar from their coral flowers; he carefully noted how one male displayed his iridescent, fan-feathered, ruby throat. He left the highway and walked toward the hummingbirds. He paused a second, wonder and amazement written all over his face, as he watched the crazy antics of these tiny birds. Then he faded away into the density of that interlaced, Summer-green woods.

Leaving that highway was certainly not to him a conscious act: the forest wasn't his element, indeed, had never been: yet the utterly ridiculous, even fantastic notion of anything happening to him never entered his head. All he knew then, or cared about, was a Wild Bee's drone, a bird's song, and those curious, Green Anolis running over the tops of fern leaves, flattening themselves at his approach.

At first, he found walking between the large trees to be easy because there was no underbrush; the ground, which was littered with Cypress needles, was soft and damp. "I'll check myself in a minute to see where I am," he said; but he certainly had no thoughts of any impending trouble.

He rested by a creek, and over its sleepy, black water, Spanish Moss hung down in long, gray clusters. In the center of this creek, a dainty Wood Duck with a golden-green head and back, and a chestnut breast, swam with his head bobbing up and down in a sort of rhythmic beat. The duck seemed to him a strange apparition because of its one, red eye fixed calmly on him.

All the usual, woodland noises suddenly ceased, and he realized that it was that time of day before noon when every beast quickly grew still. Despite the obvious fact that he was now in the deep unknown in which there was nothing save that oppressive stillness, he had, as yet, no soaring fears or empty solitude; this was so new to him, so why not enjoy a thrill?

He did, however, start a kind of left-handed retreat to safety by going in the direction of what he thought to be the highway: he walked for what appeared an infinitely long time, but he saw no signs of the highway, not even a break in the trees; so he continued his advance, telling himself, lulling himself into the belief that he should have reached the highway long ago. But when he kept seeing those tall rows of Canes surrounding him like some hostile army, he knew at last and had to admit to himself the fact that he must be lost!

At first, he guarded himself against panic, against throwing himself in a kind of senseless fury against the stalks and vines, letting them tear his clothing to shreds and against letting those microscopic, Red Bugs fall on his skin and itch so he'd have to scratch himself: all of these things would cause him to use his energy so needed to get out of this place. Yes, it was far better for him to sit down somewhere right now and to think this thing out in a logical manner; one question, however, crept into all of this logic of his: "Why did I leave that highway? Was it just to satisfy my own curiosity, or to see what was behind that curtain of Trumpet Vines, or to trespass where others had not?" He cursed himself with these questions, but now it was too late for questions!

Three Turkey Vultures flew way up on the sky, rising higher and higher, until they disappeared into the blue. Heavy beads of perspiration dropped from his forehead. Tired and a bit tormented by the unhappy turn of events, he sat down on a log, but he wasn't able to remain there long because legions of mosquitoes immediately started to cover up his face and hands.

That pitiless eye of heaven, the sun, had reached and passed its zenith, and by now found him moving onward he knew not where; he had to move, to move anywhere, with that funny-looking twig always waving about his face to keep off the Yellow Flies and mosquitoes.

He stepped over a large log only to recoil with a shock: a big Cottonmouth lashed at him, barely missing his leg; even though it took nearly all of his remaining strength, he rolled that heavy log over on the still-writhing snake.

He craved water, so he scraped away the mantle of green scum spread over an unseen, murky pool he was about to step into, and he avidly drank of it. Overhead a bird with fiery breast whistled on: it was the Yellow-Breasted Chat; its peculiar whistle impregnated the awful stillness with morbidity.

Nightfall found him covered with mud and listening to the din of tree frogs. As he lay tired and dirty against a rotten tree stump, vowing at whatever the cost to sleep, he heard a crash amid the surrounding underbrush: he saw by the light of the full, silver moon, two finely-antlered deer standing there in the clearing. He finally did close his tired eyes in sleep, forgetting altogether his growing concern about that thickly encompassing jungle.

When he awoke the next morning, the east was red with dawn, and the bird with the breast of flame whistled again. He quickly recalled that he had been almost two full days without food in this land of green gloom, this most savage land; so he drank once more of that murky water with its covering of green scum, which he slowly pushed back; he drank in long gulps

like some thirsty, wild animal. He sought the cool shade of the countless trees, yet those merciless mosquitoes were there, too!

He was hungry enough to eat some wild berries, which were certainly bitter, but they also filled his empty stomach. He saw a frog jumping in the grass: he instantly fell upon it, firmly holding it by its hind legs while he killed it. He cleaned out its insides, skinned it and proceeded to chew up its unlucky hide. In his efforts not to vomit it up, this raw frog meat made him swallow very hard. Then he ate some snails that he had earlier dug up under a nearby log. He ate everything without appetite, not from any desire on his part, only out of sheer necessity.

The wilderness mused and brooded, and the immitigable canebrake rose again before him, the trackless, the harsh wilderness against which he was now fighting for his life.

A Tufted Titmouse became annoyed because a White-Tail Deer, while drinking at the pool, got too close to her nest in an abandoned Downy Woodpecker's hole; so the little titmouse raised her pointed crest and began to chatter angrily. The deer, with antlered head, paid no heed to such titmouse chattering until he saw a large, Black Bear, followed by a tiny cub, coming into the pool to bathe and drink; the deer immediately ran for cover.

The nightshades fell. Despite the fact that he had eaten, he was still weak; and he began to develop what some might call a real anxiety regarding his situation. True, he could think, but not so clearly as before; his will to survive was still intact, but it was a will power somewhat diluted by his own physical weakness.

Under the pale, crescent moon, Flying Squirrels, which had emerged from their dead tree holes, opened their parachutes and glided from tree to tree. They were certainly having fun until the sinister Screech Owl made the scene with his spine-shivering notes of doom. The Screech Owl immediately grabbed off a Flying Squirrel in mid-air, holding onto his victim with one, firm talon, he quickly made off into the moonlight with the screaming squirrel; all because his owlets had to be fed. Long after this particular incident occurred, he could plainly hear the mad, weird laughter of Mister Night-Prowling Screech Owl, coming from his address in a dead, White Oak tree.

He heard a high-pitched squeak almost beyond the range of human audibility; he knew then that the Long-Tailed Shrew was again on the loose: this smallest of mammals trotted about nervously on minute feet. His long, thin snout was always twisting up and down, searching, searching with his keen scent; and so keen was this scent of his that his tiny eyes were of little real value to him. The shrew's appetite was insatiable: every bug, worm and spider within reach was instantly gobbled up, leaving our little friend still hungry.

The shrew finally came upon a centipede who didn't care to be eaten right then. The centipede quickly employed his large mandibles, but the shrew, darting like an arrow in flight, eluded them and crushed the centipede's head. The headless centipede continued this now hopeless struggle with the coordination of its efforts scattered. The crafty shrew, the smallest and most energetic mammal, simply swallowed one by one the countless segments of his enemy, enjoying all the while his latest meal ticket.

The only thing that deterred the shrew from his path of wrath and hunger was the mating call of the female shrew; when he heard this, he was off like a shot to other, more pleasant pursuits.

As he watched these various animals going about the deadly business of their daily existence, he began to learn something from nature: the smart, the more cunning and the strong, yes, above all, the stronger, survive; and the weak ones perish; their flesh makes the earth that much richer for the survivors who now walk on it. "Nature is seldom mild," he slowly repeated to himself. So he became that much more determined to be raw enough to fight his way, by hook or crook, out of his hellhole. It was with such a thought that he fell into a deep sleep, only to awaken from it later on after having an awful nightmare, during the course of which he dreamed he was wading around in a black lagoon full of Cottonmouths; he naturally awoke sweating and screaming out loud, "Snakes, snakes!" weaker than before with sheer fright. He calmed himself later on simply because there was no one else there to do it for him.

He pushed onward again through the humidity and the green density of early dawn. He now found himself dragging his feet; each step was becoming harder to take. It was too late and he was much too tired when he first saw that rattlesnake: he could feel the sting of being bitten, but he really didn't understand what had happened until he felt the authentic pain of the poison as it shot up his left leg, growing more and more unbearable by the second. He remembered then that he had a pocketknife; he took it out of his right pocket and made a crossed incision just above his left ankle where the twin fang marks were two red dots on a white backdrop of flesh. He sucked out the poison and spat it from his mouth onto the damp ground; he performed this function with a gesture of contempt; why, he couldn't tell. His tears of blind agony blurred almost

everything, but he still found the raw guts to smash with his heavy boots, the flat, hammerhead of that sinister rattlesnake!

As his breathing grew more and more labored, he heard the Mourning Doves cooing, and high above the green glade, two Snowy Egrets flew majestically and leisurely upward to the sun. "I'll try to catch one of them" he shouted until the forest, that cruel, green forest echoes and re-echoed with his vain, senseless cries. "Maybe they can show me a way out of this place," he said, not believing then what he said.

He plunged with renewed energies, springing from he knew not where, through that dense cover of vines, canes and briers, everything and anything that stood in his path; he was determined to catch one of those two wonderful, white birds. Then he saw before his eyes that which he once thought he'd never see again, the highway: there it was, hard and bright white in the harsh, morning sunshine; he fell down upon its baking surface, kissing it; and he heard the distant rumble of an approaching truck.

PART XII.
STRANGE NORTH CAROLINA BOGS

The sun rose swiftly, hovering over a large, white cloud hanging low in the sky. The heat, which had become unbearable, now turned into an inferno, as the sun's rays bore down on us. The tar surface of Route Number Two, eight miles south of Wilmington, North Carolina, shimmered in this intense heat. We had reached the mysterious Peat Bogs of the Wilmington area, and our bodies, which were covered with mosquito bites, itched painfully; the Yellow Flies also attacked us in savage hordes, but we kept swatting them methodically from our faces, muttering in hopeless anger.

On the right side of Route Number Two, the sand dunes stretched for half-a-mile, and the land forming them was of a peculiar whiteness; on these sand dunes, dwarfed oaks and pines were growing.

Then, after half-a-mile, the sand dunes abruptly ended; and in their places, were very large, round depressions in the earth several miles in circumference. On the other side, across each of these large, round earth depressions, were more sand dunes; this continued endlessly. Each of these curious, earth depressions was a Peat Bog.

Amazing insect-catching plants grew inside of these Peat Bogs; they grew in a little world of their own there amid the perpetual greenness of the peat moss and ferns covering the bogs themselves. The green cover of the Peat Bogs was rendered greener still by the whiteness of the sand dunes, so that it appeared to be a dark green; this dark green color was broken in places by brilliant spots, and these spots were the reflected surface of small, stagnant ponds. Upon the black-ink surface of these same ponds, grew the Marsh Marigolds; their yellow blooms resembled gems placed on black velvet.

All about the small ponds, Cattails stood as straight as cadets on dress parade, and beyond them were the Venus Flytraps, this strange and famous member of the plant world: they grew in compact clusters, and the crimson of their leaves strongly suggested scattered rose petals on the green peat moss; then we understood, as never before, the fascination this plant exerted over some insects. With the magnificent surges of Spring, and with the new sap flowing freely through them, they could feel that deep tempo of life violently beating once more; and they stood poised and waiting for any insect that they could wantonly grasp in the clutches of their traps. Although insectivorous plants, like all other plants, they contain chlorophyll and are able to obtain their energy from the sun, the soil on which they thrive is acid and deficient in nitrogen, so that they must snare insects in order to make up for this deficiency.

The circular leaves of the Venus Flytrap were like spring traps mounted on narrow, radiating arms. Along the outer margin of each leaf blade composing these traps was a row of stout teeth. Whenever a butterfly hovered over them, or an ant touched any of the three sensitive hairs which were in the center of each leaf blade, the two halves of the leaf sprang shut, folding along the midrib, bringing together the two rows of teeth, so that the insects were held fast; the Venus Flytrap would then remain closed until they were thoroughly digested: this might take from two days to a week, depending on the size of its quarry.

These Venus Flytraps were operated by an ingenious mechanism: each leaf blade had two types of cell layers; on the upper surface of the leaf blade was a layer of live cells, which when turgid, exerted a downward pressure on a corky, springy layer of dead cells located on the lower surface of the leaf blade. Whenever an insect came into close contact with the sensitive hair on the leaf blade, it caused the upper layer of cells to lose their turgidity, and the corky, dead layer of cells on the lower surface, having no longer any pressure bearing against it, acted as a spring and snapped shut the trap. This whole, intricate mechanism depended on osmosis, which is the diffusion of a liquid through a living membrane, and is one of the most essential processes in the growth of plants.

Besides the Venus Flytrap, other insectivorous plants were also waiting for their quarries: there were the Trumpet Plants, and among the darkened trunks of the short pines which had recently been burned by a devastating fire, they erected hundreds of yellowish-green tubes which stood from two-to-three feet high; within the interiors of most of these tubes were countless victims, and these victims were insects of varying orders and species, ranging from Hemiptera, craneflies and moths; although in some of the tubes, the only victims were of a small species of longhorn beetle. The poor insects, which had been enticed into the Trumpet Plant and trapped by its sticky, sugary fluid lining its tubes, were lost forever within its great depth; innumerable little bristles, pointing downward, made it impossible for any of them to escape in any direction. Their fate was to drown in the water that the plants collected during rains and which partly filled their tubes. In due time, the external digestive juices of the plant would partly dissolve the insects, and they would be absorbed by its living tissues. Some of these plant tubes were so filled with partly digested insects that they exuded unpleasant odors. The only tubes containing no insects at all were those inhabited by certain long-legged spiders of the genus *Tetragnatha*, who had found a home and a place to make a living.

In the shadow of the Peat Bog, was yet another species of curious, insectivorous plant known as the "Pitcher Plant." The green leaves of the Pitcher Plant were more or less suffused with purple and had their margins united so as to form quaint, little pitchers. These little pitchers were similar to the long tubes of the Trumpet Plants in that they were also living traps, traps giving a prey no quarter.

The red flower of the Pitcher Plant, mounted on its long stalk, gently swayed in a lazy south wind; and a Mourning Dove repeated its plaintive notes for approximately half-an-hour; then a Bittern, with a rush of his powerful wings, rose from a Cattail thicket. It was about an hour before dusk, and its nearness could be felt over all the land. The yellow-green tubes of the Trumpet Plants appeared as rather odd objects made of light-colored celluloid, and towering above them were the somber silhouettes of burned pines.

The most bizarre, the most astounding plant or animal is sometimes quite inconspicuous: we had, thus far, been totally unaware that the ground beneath our feet was literally covered with Sundews. These little boy herbs of the insectivorous plant world, so minute in their green surroundings, defied the attention of even the cleverest observer. The sparkling dew which covered them glistened sharply under the receding evening light, and in the shadows, a common crab spider walked rapidly. Throughout the day, the crab spider lay in ambush among the wild rose petals, moving stealthily upon insects coming to feed on its nectar; it stalked its victims with its powerful, specialized forelegs, then sucked its body juices until the victim grew limp and died, and finally discarded the empty carcass to the four winds.

But now, being impelled by some unknown, natural force, the crab spider advanced rapidly, climbing with great dexterity over the grass blades obstructing its passage. He halted, feeling with his palpi for a brief moment, then hesitated as if he could sense the nearness of an imminent danger he couldn't fully comprehend; he then proceeded on his way and began to ascend the Sundew stem. As he reached the paddle-shaped leaves, what had once appeared to be a harmless dew, was now, in reality, a sticky fluid which served to entice and to trap the Sundew's victims.

At first, the crab spider became only slightly entangled in the sticky fluid; and there was a violent struggle on his part to get free, but this was in vain because it only served to get him that much more entangled. Already, the many little, red tentacles covering the Sundew's leaf had moved with a slow but sure grip over their prey. The fear of death was now deep within the crab spider, and he made frantic efforts to free himself from these now-closing tentacles; but their relentless grip altered not, indeed would not relent until the spider was reduced to a putrefied ooze to become completely absorbed later on into the plant's own hungry, living cells. At last, the spider's struggling stopped, and the Sundew's little, white flowers moved by the gentle evening breeze, nodded with a kind of nonchalant innocence.

Darkness rapidly crept over the bog, and a light fog began to form above its floor. The crests of the sand dunes made gigantic shadows under the light purple sky, and above the sand dunes themselves stood some dead trees with their grotesque forms and smooth trunks glistening in the moonlight; they appeared as so many white ghosts.

PART XIII.
LAND OF THE ALLIGATOR AND PIGMY RATTLER

Some distant tree frogs mysteriously spoke, "Na-Naa-Haha-Aaa!" a very low cry, yet piercing; in the still, dewy morning of this wasteland, these echoes sounded even stronger. While far out in the water, fishes quietly swam. Suddenly, birds were singing out

loud and clear with their ringing voices, and the brush itself became aflame with golden sunshine. As he was warbling on a twig, a male Painted Bunting's varied color scheme of bright red, green and indigo metallic sheens glowed in the early morning light. Bank Swallows were high up in the sky, and by the edge of the river, Foxtails were knocking their heads together in the wind. The Spatter Docks, so full of golden pollen, were very yellow on the dark water. Egrets and herons stood erect in the sunshine, and a huge caterpillar, with a painted tail and white bands, twisted nervously on a blade of grass. The Hummingbird Moth drowsily flew, and turtles bounced into the water with loud splashes. Snakes came out along the banks to sun themselves.

We moved into the woods, crossed the low ground and entered the sand dune region.

There was Robby, who was six years old, and who had been born and raised on the borders of this wilderness; at six, he knew more about the wilderness and its creatures than many of those three times his own age. He knew all about reptiles, birds and mammals, and could distinguish the differences between species among the countless insects: Robby, who to be sure, didn't know their Latin names, but who certainly knew a good deal about their natural ways and habitats; a born naturalist himself, their Latin names would come to him later on in life.

Less than an hour ago, Robby had expertly caught a six-foot Coachwhip without once getting bitten by this non-poisonous, yet fierce and extremely fast reptile; one simply cannot imagine how swift this snake is on the ground until one has seen it in action, but little Robby got a good start on him, and he didn't stand a chance! If only the reader could have seen Robby sprinting along like some rabbit over the sand dunes, then suddenly plunging on his quarry, then standing there later on the dune, grinning like a possum, holding fast to this prize! Sam, also a member of our party and himself a bird lover, was afraid of snakes and dared not approach Robby until the Coachwhip was secure inside a bag; then Sam returned to his bird watching, while the rest of us hunted Pigmy Rattlesnakes. Later on, Robby spotted our very first Pigmy Rattlesnake in a tree stump; and our party spent the best part of the morning demolishing old tree stumps; we found a total of five Pigmy Rattlesnakes.

Then we all returned to camp, built a campfire, and while fighting the blowing sand and smoke, cooked ourselves some steaks and sat around the now-smoky fire eating steaks full of sand grains, as we talked of snakes, insects and of the fauna of the locality in general.

Later on that same afternoon, we all went to the bogs to gather Venus Flytraps, Sundews and Pitcher Plants for the museum collection; it was sunset when we returned to camp. Four of our party trailed behind me: Maurice, Sam, Robby and Larry came up the narrow path carrying on their shoulders cardboard boxes full of Venus Flytraps and Sundews; the wilderness closed in behind them.

I sat silently, watching the sunset over the dunes. Robby's father spoke to me, "Hey, how 'bout goin' Alligator hunting tonight? I've got the gear, flashlight and all."

"That's a good idea," I answered; so we immediately attached the boat trailer behind the car and started down the highway; we drove in darkness through what seemed to me an endless archway of trees; in an hour, we arrived at our destination. From the darkness, came the hoarse, melancholy, weird and anguished sounds and sighs of night birds. In the center, was that lonely highway; and on either side of it, the swamp, infinite, indomitable; while above our heads, the waning moon and that suspiring song of the wind; and the long Spanish Moss covering the trees trembled. Coming from the depths of the dense jungle itself, were the strange mating calls of a dozen different frog species, also the fluent and fluid song of the Chuck-Will's-Widow; these were night voices fusing with the impenetrable jungle itself until they were a part of it. I listened motionless to all of this while contemplating the waning moon. The bloodthirsty mosquitoes craved my hide.

We finally launched our boat. We saw all around us glistening water, and reflected in it were the shadows of low-hanging Spanish Moss. All was calm and quiet. There were only a few ripples on the surface of the still water caused by the movements of our paddles. We moved onward in darkness. We passed huge Cypresses and Gums with their branches twisted into all sorts of shapes.

Then, suddenly, we heard a strange, continuous buzz which gained in volume and intensity as we drew closer to its source. We turned the flashlight on it, and in a large hole in the trunk of a gigantic Cypress tree, thousands of Wild Bees were busy on honeycombs. Robby's father hastily marked this spot for our future reference, while I insisted that we depart from these ominously buzzing insects as quickly as possible.

As the boat continued its steady progress, I could see that we were now in much more open country, as the creek suddenly became a much larger body of water.

Larry's flashlight quickly picked out two big, phosphorescent eyes in the tall reeds near the riverbank; then there were two more, and still another

pair! The Alligators there in the reeds were quiet as death itself, and we came close enough to see them floating with their armor-plated backs and heads partly above the surface of the water; there was something about them antediluvian in appearance.

The waning moon dipped behind a cloud. Those phosphorescent globes that were an Alligator's eyes continued to peer into the darkness, and the whistle of the Chuck-Will's-Widow came at longer and more irregular intervals.

Robby's father corrected his little son: "Durn it, why can't you paddle just a little faster? And quit makin' so much fuss with that paddle!"

Quietly creeping up, we came closer and closer to the gators. I was at the bow of the boat with my noose ready on the end of a long stick, while Larry held the flashlight in the Alligator's eyes. I could now feel my own heart beating fast with excitement as we drew very close to one of the big beasts. I almost had my noose around its neck, but still the beast, blinded by the flashlight in his eyes, didn't move! Now the noose was around its neck, yet it seemed to feel nothing! Then I yanked the noose very fast with a backward and upward motion; there was a strong pull on the noose, and everything seemed to break loose at once! The Alligator pulled, so Sam and I also pulled! Finally, after much effort on our part, the beast was brought into the boat. There was a great twisting and flopping of his powerful tail, as the Alligator broke loose inside of the boat: everyone in the boat grabbed something; two of us caught hold of the Alligator's head and the rest of us grabbed for his now-swishing tail. At last, the eight-foot-long, twisting gator was brought under control and dumped, securely tied, into a burlap sack. The boat became steady again, but all of the commotion had driven most of the Alligators beneath the surface of the water.

In about half-an-hour, another pair of those same glowing eyes were spotted in the tall reeds; and once more we slowly advanced on the Alligator, I with my noose ready! Someone made a slight noise in the water with his paddle, and the Alligator with a bubbling sound, disappeared into the abysmal depths; I could then hear Robby's father, who had become infuriated by this latest failure, heatedly cursing out someone in the darkness.

As we paddled through the reeds, schools of Mullets, who frequently swam just below the surface, became frightened by our approach and jumped from the water into the air, some accidentally falling into our boat; before it was all over, there were at least two dozen Mullets flopping about at the bottom of the boat, and these we placed in a bag for later use. We also stopped once in a while to catch one or two large Bullfrogs. The air had become chilly, and the voice of the Chuck-Will's-Widow was now strangely silent. We all felt somewhat cold and uncomfortable in our damp clothing, so we made for the shore.

Once safely on shore, the flames of our log fire leaped up and brightly lighted our clearing while we fried Mullets and Bullfrogs impaled on the ends of sticks held over the flames. Larry, who had gone somewhere in the deep woods, quickly returned with a bag of apples; so we ended up with fried Mullets, Bullfrogs and apples for dessert. It was now two o'clock in the morning: on all sides, the trackless wilderness scared and mused; and the night sounds gradually diminished. After a restful period spent around the campfire, we were once more prepared to paddle away through reeds and swamp.

At the base of a Cypress tree, Robby's piercing eyes noticed a big, nest-like structure made of roots, twigs and leaves, containing many baby Alligators; some of them with their long snouts and large, topaz, narrow-pupilled eyes protruding out of their leathery shells: we counted, in all, twelve baby Alligators. I was personally both delighted and excited over this important discovery because it was my first Alligator nest.

Frolicsome nighttime fires, whether they be those of a type of phosphorescent fungi, glowworm, or the fingers of moonlight lingering at the calm water's edge where the reeds tremble in sharply accented shadows, or if they be the flowing eyes of some animal full of dancing, amber fire, bring into the landscape such fleeting tonalities that are so faint and so subtle, mere words cannot do them proper justice; the faintest hues, which do so much to enliven the breathing darkness and cause it to appear even deeper than it really is, are those soft colors of the night which only the accustomed eye can detect.

The moon reappeared very rapidly, and with her thin beams, she illuminated the forest with her wan light. The trees, silhouetted out of all proportion to their true size, expanded their gloomy branches until they seemed like the ferocious tentacles of some giant octopus. All appeared to slumber, and the mild Summer breeze did scarcely caress one with its own subtle breath.

Quite unexpectedly, the echoing call of the Great-Horned Owl abruptly tore through the silence; it was a call both terrifying and majestic. I saw him perched at the very top of a dead oak tree; his shadow, reflected in the moonlight, appeared dismal to me. The two great phosphorous discs that were his eyes added a tone of ferocity to the scene. The owl suddenly plunged down, cutting the very air with his noiseless wings; all at once,

his shadowy form was swallowed up in the obscurity of the pine thicket: then again, he quickly reappeared, and just as quickly, disappeared. I heard the agonizing cry of a Muskrat who had unwisely fallen prey to the owl's sharp claws. "Be on the alert, oh rabbits, mice and other mammals, for the master of the night is on his hunt!"

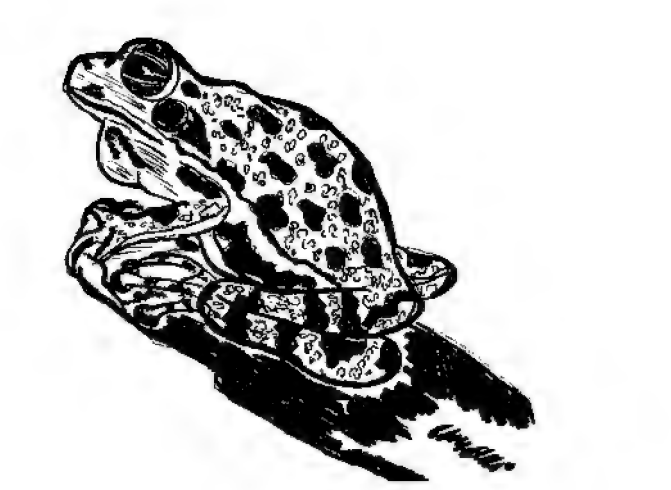
Onward we paddled into the endlessly pale moonlight, until all of my crouched companions seated in the boat bore about them a spectral look. Again, more Alligator eyes were sighted, and we cautiously approached, our paddles barely making a sound. Now the floating body of another, larger Alligator was caught in the beam of our flashlight; it was, by far, the biggest we had seen; it appeared to be at least ten feet long, but the moment we came within reach of it, it quickly plunged under water. We searched up and down the creek for half-an-hour, finally locating its eyes in those tall reeds, only to have it plunge once more under water! This game of hide-and-seek continued for around an hour-and-a-half, with the sly Alligator always plunging under just as I was prepared to pass my noose about it. On several other occasions, we saw its antediluvian form resting upon the silty bottom of amber waters, too far down for the possibility of capture: at last, in high disgust, we gave up this unequal chase.

We passed under a low bridge, and as we entered its low arch, birds suddenly began to fly all over us; we grabbed at pure random; turning on our flashlight, we saw that we were holding two Kingfishers and several Barn Swallows who had been soundly sleeping there. The Kingfishers began uttering their hard, piercing notes, also biting the fingers of their new tormentors. After having carefully observed these beings of the avian world, we very kindly turned them all loose.

As we arrived at our departure point, dawn crept over the land; so we loaded the captured Alligators into the truck and made our way back to camp: at first, due to the heavy fog, we didn't drive too fast; but gradually, as dawn advanced in the sky, the fog lifted, and we could now see the thick woods on both sides of the road, with an egret still in her full nuptial plumage, gracefully walking among the trees. Because Sam wanted a picture of one, on our return trip, we stopped over in the great marsh to observe a Marsh Hawk's nest; we also saw some Otters playing by the shoreline.

PART XIV.
LATE SUMMER RAIN

It rains and the big woods dissipate into a gray shadow. The jungle beats with mysterious life. A Snowy Egret with a long neck and a yellow beak,



stands erect, immobile like some stone statue as its white silhouette reflects and lengthens in the inky water. Cypress knees project above the surface in grotesque rows. Everywhere, twisted roots lie mixed atop the alluvial soil. Behind the Snowy Egret, tender, green pine needles stand out in bold relief. Underneath rotten logs, worms and larvae twist around, and dead trees precariously oscillate in the warm wind.

It rains and beneath the gray mist, the somber foliage shudders. The monotonous voices of the Barking Tree Frogs beat a sort of cadence to the silence; their voices are indeed a part of such silence and solitude. The forest seems to breathe deeply. White Lilies in the shadows appear whiter still, and their petals are faintly suffused with green. Large Cottonmouths lie coiled up upon the lagoon's shore, while still others are swimming with sinuous movements, their heads trailing above the surface like small periscopes. On the soft earth are the tracks of bears, wildcats, possums, coons, Otters, Mink and of numerous smaller animals. In the dissolution of dead branches and leaves, numberless insects employ complex metamorphoses. There is also that dismal buzzing of millions of pairs of mosquito wings vibrating together in perfect unison and mixing their sound with that of the drizzling rain.

It rains and the melancholy song of the rain echoes in the solitary, great woods. A Red-Crested Woodpecker drums away, then just as quickly ceases his drumming as a bear noiselessly passes, then drums again. The strident, laughing call of the Pileated Woodpecker rings out in these gloomy swampland alleys; and through the canebrake's density, an Eastern Diamond-Back Rattlesnake, who carries more than twelve rattles on his tail's end crawls heavily and very slowly. Fungi, such as Amanita and Russula, pierce through the damp humus with their bright colors; and on such a mossy carpet as this, a small reptile banded

with scarlet, yellow and black, both wiggles and vibrates his small, black, forked tongue: this living jewel is the Coral Snake whose fangs bear the name of death. The bushes tremble; there is a momentary presence of a fallow light, and the ghostly wildcat with fiery eyes has already disappeared. Among the grasses bordering the river, the amber eyes of Alligators reflect upon the water that small portion of remaining light.

It rains and the great swamp is gradually annihilated by a mist that engulfs the gray effluvium, the bottomless horizon.

I peer into the gray day and unload my sleeping bag that is now soaked through and useless; hoping that it will dry out later on, I hang it on a high branch. My arm is heavy with a bag of snakes I'm currently holding; in the other hand, I hold my precious snake hook which I used in capturing them. Steve, my companion on this trip, also holds a bag containing our prize possessions: two large Banded Rattlesnakes and one Diamond-Back Rattlesnake; each time these snakes are moved about too briskly (which is often) we can both hear their dry rattling.

Steve keeps on saying to me, "Look over there!" and I look where he points; but I can't, as yet, see anything; he keeps right on pointing, saying all the while, "Over there, over there!"

Now I'm slowly but surely beginning to distinguish a gray snake on a gray branch: in fact, everything from the Spanish Moss to the tree trunk, its branches and the horizon itself, are all very gray. Since it is a non-poisonous, Brown Water Snake, I grab it with my bare hands; it makes a vicious attempt to bite me, but I firmly hold it by its neck; I can feel, through my hand, the growing strength of its powerful body as it continues to struggle for freedom. Steve holds the bag open as I drop the Brown Water Snake into it, along with the other non-poisonous species already in there, such as: three Red-Bellied Water Snakes, two Banded Water Snakes, twenty Brown Water Snakes, one Rainbow Snake, one King Snake and two Corn Snakes; the Rainbow, Corn and King snakes are there only until we can find another bag for them.

Steve keeps on talking all the time: "Say, that last one was sure a big snake; it's not often you see one like him."

"I'd say 'bout five feet long," I reply.

So we discover ourselves moving once more through the gray day, with the rain now falling in precipitation; I can feel the unpleasantness of water dripping down my back, while Steve trails behind, sagging under the weight of his wet clothing; his hair plastered down against his head and the little rivulets of water coursing down his face give him the appearance of a Trappist monk.

At last, we reach the highway where yesterday we parked our automobile; it is indeed time, for now, the rain becomes a real deluge. It does feel good to change into some dry clothes after a day and a night spent in the wet and soggy woods. After a meager meal of cheese and bread, we both roll into our blankets and extinguish the kerosene lamp.

As I lay there in a semi-trance-like sleep induced, no doubt, by the monotonous beating of the rain against the metal rooftop of the car, it was as if I could hear the vast forest speaking, softly whispering: "Man was not yet born, but already, I was the forest, the forest old, yet continually young; young again with each new Springtime bringing the rising sap and the spreading of new, green leaves.

"I can recall the time when Indian tribes roamed through my endless density, who were hunting my deer and my bear with their stone-pointed arrows; one can still see the evidences of their hunting expeditions, marked by the scattered arrowheads yet to be found there. All this was in that happy time when I extended in an almost unbroken alluvial swamp right to the tip of Florida.

"Now, however, highways and canals have been built, crossing my density. All this began soon after the arrival of men with light skins who came ashore on what was then a new continent, not yet known as the United States. These light-skinned men were indeed strange beings, the like of whom I'd never seen before. Unlike the Indians who came before them, who sought to adapt themselves to their environment, these strangers sought only to change their environment to suit their own whims. He began to attack the trees that he used to build houses and barns. He drained large pieces of land and began to plow under the humus that had, through the years, been formed by decomposing leaves.

"The time, however is not far in the past when I covered vast areas now inhabited by man: how long ago was that? Two hundred years, perhaps; two hundred years, for both man and beast, is an eternity; but for trees, who are several times centenarians, it is hardly the time for a few generations!

"When, at last, the murmur of the young trees seems to cease, the older ones continue to speak of the ancient past: they relate a time when Passenger Pigeons flew in such enormous columns they obscured the horizon and how they came crashing through the trees in masses to roost at evening, how branches broke under their weight.

"They also speak of the great panther, or Mountain Lion, who once kept down the deer population; but the

panther no longer slinks in the dense briers; gone, too, is the Ivory Bill Woodpecker and the Carolina Parakeet who used to cavort in gay, colorful groups; alas, all are forever gone! Even the Bobcat has almost vanished, except in some of the more remote areas, where its soft paws still mark the black mud.

"Despite man's many encroachments I am still a vast land unvanquished. I am the indispensable forest, regulator of water, purifier of air through that secret work of the leaves known as 'Photosynthesis.'

"I vibrate and sing like the softest harp. I am a deep temple with millions of colonnades. I am an asylum of peace dear alike to both philosopher and poet. I am still the forest eternal and unvanquished!"

PART XV.
BEAR HUNT

The first rows of the cedar grove, so deep and so cool, began just beyond the clearing, after which came the canebrake at least four miles in extent, in which also grew a variety of hard timber. Before us was the motionless canal, and on the other side of it, dense woods for twenty-five miles before the first highway broke through them, and beyond that, still more dense woods.

At eleven o'clock in the morning, because of the distance, the first staccato call of the lead hound was indistinctly heard near the highway; and immediately after this, the other hounds also bayed. Nothing more was heard until the afternoon, when all of the hounds again bayed; they were obviously on a cold trail. In order to obliterate his own scent, the bear must have passed through the first clearing near the highway, then taken off through the low, wet ground; that old bear certainly was cunning! The hounds were badly deceived for sometime; we sat there by the canal listening to them run all over the first clearing; however, after a while, the old lead hound crossed the wet ground and once more picked up the bear's scent; it wasn't long before the other hounds followed their leader.

While all of this activity was taking place, the old bear remained hidden in the canebrake at the cedar grove's edge, standing motionless above the short canes, contemplating his surroundings with calm assurance; his subtle olfactory sense had promptly informed him of the dogs' presence. With his hair erect, his ears trembling, he was waiting and listening to the calls of the hounds. The old bear, who had been hunted many times before this, was almost invincible: before coming to rest, he had described a large circle five miles in circumference, crisscrossed it, then traced several smaller, concentric circles; it took the hounds quite a while to figure out this maze.

Steve, my faithful companion on this particular trip, stood among the Cattails at the canal's edge with a mane of black hair almost like the bear's, holding the big, double-barreled shotgun, waiting and hoping to get a glimpse of the elusive bear.

As the hunt continued, some of the younger hounds often got lost on other trails, but the old lead hound was never distracted; he was hunting the bear and no other animal; his regular calls rallied the other, dispersed hounds.

A Red-Tailed Hawk with a majestic sweep of both wing and tail, alighted on a nearby branch; I kept very still and observed this large and powerful bird of prey.

There was a certain crispness in the air which had come with the approach of Fall: the leaves, however, were still green; they would not change much, for in the great swamps there is seldom that vivid display of color so characteristic of cooler climates. The leaves usually appear to wither without taking on different color tones. Winter comes quite suddenly, and despite that certain crispness, it was still relatively warm. Even if Fall couldn't be told by the color of the land, there was a certain melancholy feeling all about us: perhaps it was the lack of song, for most of the birds were silent; indeed, outside of a few, scattered gunshots heard during the morning hours, the woodland was quiet.

Several Great Purple Hairstreaks of a later brood were zigzagging about a clump of Spice Bushes, forming a sort of last, vestigial aspect of Summer life; the Great Purple Hairstreak has the most brilliant, changeable coloring of any of our butterflies. The species occurs throughout the southern half of the United States, having spread northward from Central America and Mexico. Its larvae exist on a diet of Mistletoe leaves.

Quite suddenly, twigs began to crack like whips in the stillness; and the first, gaunt hound with long, flopping ears and a wagging tail covered with rusty spots, appeared with his nose to the ground. The hound expertly sniffed a clump of grass, took a few backward steps, then returned to this same clump of grass, moving his head back and forth; he turned around a small bush, then again returned to that same clump of grass; then after suddenly making a quick decision on all of his reflections, he bayed and was off into the cedar grove; the rest of that thin bunch with their flopping ears followed.

The bear, who stood in the short canes without moving, was alerted by the hounds' clamor: he advanced silently through the thick curtain of canes and briers, coming out about a hundred feet from where

Steve stood in the Cattails; it was then that I heard the twin blasts of the shotgun, but the bear was too far away and his thick hide was hardly grazed by the buckshot. He swam across the canal and disappeared into the dense woods. We recalled our hounds and put them on a fresh scent on the other side of the canal that we crossed on a big log. The hunt continued all the rest of the afternoon, with that old cunning and invincible bear leading the hounds astray each time on false trails; it developed into a real match between the bear and the experienced, old lead hound.

Later on that same afternoon, we saw the old bear again: this time he was running across an open field on the wet ground, with the hounds close behind; however, they were much too far away for any of us to get in another good shot at him. This time he again outmaneuvered his pursuers by swimming across a small lake; the dogs, who knew better than to follow him into the water, circled the shoreline; but the old bear had reached the opposite shore first and had slipped away another time.

Now we all followed this hunt much more closely because we knew that our quarry was tiring. That old invincible bear, after his crossing of the lake, had walked along the trunk of a big, fallen tree which stood a few feet above ground; for awhile, even the old experienced lead hound had lost the scent. We had hunted this old bear for many a year, but each time, the old one had outsmarted us and our dogs; with each new year had come our strong desire that this would be our lucky break and that we would eventually outsmart him after all.

The wind brought to us from afar the muffled sounds of more barking and again there was silence, then this barking commenced a second time and seemed to come nearer to us; we now realized that the hounds were very close to the bear. The barking became stationery, had more continuity to it and grew stronger than ever. The old bear, who had run all day long, was now utterly tired and was making his last stand against the dogs. We figured that he must be about a mile away, on the other side of the low ground. Dashing through the woods and canes, and tripping over stumps and dead branches, we ran in the direction of the barking hounds. When, at last, we arrived upon the scene, we found the old bear to be an imposing spectacle indeed as he stood there erect on his hind legs with his forelegs spread apart in the air, ready to slice wide open with those razor-sharp claws of his the first dog to even dare to come close to him. The hounds, harassed by the long hunt and torn by the briers, were much infuriated by the bear's closeness: they howled with anger, baring their teeth and growling. There was that old bear standing up there holding himself so proudly erect, and behind him, the sun was slowly sinking into the western horizon: it was all arranged in such a dramatic way that the figure of the bear was rendered in bold relief against that big, red globe, the eternal sun; all of which caused the bear to appear larger than life to the naked eye: and that gang of baying hounds kept encircling him.

Finally, one of the younger hounds jumped toward the bear; with a swipe of his left, front paw, he sent the hound flying into the air with a howl. The pack of dogs immediately stepped back as one; only the old hound alone didn't move: he remained in the bushes, simply flattening himself against the ground, waiting with fiery eyes, waiting for the right moment to pounce at his enemy's throat.

It had been a long and a good hunt; somehow we felt that Old Invincible had earned his freedom for that day: we began to call off the hounds, to say the least, a most difficult job: however, we finally managed to tear them every one away from the old bear and to place leashes on their collars and to drag them off. The young bitch who had been so intent upon attacking the bear, now had a long, deep, red gash across her back; she walked with her tail between her legs; we knew that we must attend to her wound as soon as we reached camp. We just didn't have the heart to shoot down that old bear in cold blood; after all, what would the big swamps be like without the supreme thrill of chasing Old Invincible each Fall?

PART XVI.
FALL AND WINTER

The sun's rays beat down but not so fiercely as before; though warm waves could still be occasionally felt, there were days of cool weather; however, these would be replaced again by heat, as soon as the cool waves blew away from the sea and were lost as they scattered over the still-hot earth; nevertheless, the sun's intensity was subtly waning. Over the sprawling mystery of the great swamp, Summer's cycle had closed; and some of the turtles, among them the Spotted and Little Musk, laid their final batches of eggs in rotten stumps.

The "Ka-ka-kowp-kowp," of the elusive Yellow-Billed Cuckoo was no longer heard; and for the first time, this bird, so hard to see because of its secretiveness, could be more easily seen as it was observed flying rapidly from cover into the open, then back again to cover, as it became more gregarious in readiness for its trip to South America.

Summer colors were rapidly fading; there was,

however, one, last effect of Summer's effort: mushrooms, many of which had grown more or less erratically throughout the Summer, were now blooming in a multitude of varied colors and species. In the dimness of that forestland, there grew on a very fragile, high stalk the immaculately white Death Angels, the most deadly organism of the vegetable world, against whose potent poison there is not yet any well-defined antidote; this very delicate but most deadly of the higher fungi, grew in several varieties: the Lemon Yellow Amanita, which is almost identical to the Death Angel variety except for the faint lemon yellow mixed in the ground color, and the Deadly Amanita, faintly suffused with olive brown; these three fatal varieties of the mushroom family grew either singly or in small groups.

Then there were the boleti, with a heavy foot and pores under their caps instead of gills. The Death Trumpets were black and resembled a trumpet.

There were those species which grew on the ground and those which grew on tree trunks: among those growing on tree trunks was the Hedgehog Hydnum, a species which does not tally with one's conception of a true mushroom; it strongly resembles a fair-sized, creamy white ball with downward growing spines on it. The Oyster Mushroom bears the name of that luscious bivalve because of a fancied similarity to it. Less common is the *Hydnum caput-medusae*: freely translated, this scientific name literally means, "Head of the Medusa"; the wavy appearance of the slender spines of this particular mushroom recall to one those snaky locks of Medusa herself, hence the name. Also growing on tree trunks were other bracket fungi whose fruiting bodies were as hard as the wood itself.

Among the ground dwelling varieties were the Bright Capped russulae, outside of the immensely large group of boleti, one of the biggest families of higher fungi. Many of the russulae species are very difficult to distinguish one from another: there were the collybiae, *Collybia radicata*, a species with a thin, tall stalk; so tall, in fact, in proportion to the plant itself that the least air current causes it to vibrate all over.

One mushroom, *Clitopilus abortivus*, exhibited two forms of the fruiting body: one form, the abortive form, somewhat resembled a puff ball; while the normal form was an attractive mushroom.

I could continue with this description of the endless variety to be found among the higher fungi, however, this is not a book on mushrooms; so allow me to simply state here that the number of species seems infinite.

In this modern age of deep-sea diving, we often hear much about the wonders of those colorful ocean depths; let me say right here that the multicolored fungi are, in my own estimation, as colorful as anything to be found among the barrier reefs. As a matter of fact, the coral mushroom very much resembles the sea corals: *Clavaria fusiformis*, a coral mushroom, shoots like tongues of flame from the mossy beds of the cool woodland; indeed, mushrooms are the true colors of the deep woods, and in those gloomy depths of the swampland, their bright tonalities often carry with them a certain spookiness.

The attractive mushroom itself, as we know it, is not the main part of the plant; it is only the fruiting body. Mushrooms reproduce by means of spores which are generally formed on the gills, or in tubes under the cap, as in the case of the boleti; these spores are very tiny and have been known to exist at high altitudes, having been carried there by the wind currents; as a result of this, mushrooms are very widely distributed. The mushroom plant itself, known as "Mycelium," is a vine often forming a vast network; the Mycelium is formed by the germination of spores.

Mushroom hunting can be a most interesting avocation and is not without its rewards from a gastronomic and scientific viewpoint.

The mushroom is a vegetable that centuries ago graced the tables of the caesars. There are, however, no set rules by which the poisonous and the edible species can be distinguished within the same genus; one must first really know the species; rest assured that knowing the many species is a study which can be followed with thorough intellectual enjoyment.

Around the middle of September, a hurricane passed over the big swamps with a furious velocity: the wind whistled dismally as it felled trees and stripped them of their branches, and the driving rain mercilessly beat down upon the soil. In this dark tempest, some birds flew erratically in their blind flight; the Sooty Tern, fleeing the storm's violence, was brought into the Tidewater area for the first time from Florida's Dry Tortugas. The Raccoons and squirrels, safe in their tree holes, awaited the hurricane's passage; however, many not so fortunate animals were flooded out in their own retreats as the water level rose everywhere.

The tempest finally abated, and on the morning of the third day, the sun shone; the sky was once more blue; freshly broken branches and leaves littered the forest floor. Some of the most secretive creatures of the very deep, such as the Sirens, Amphiuma and the Mud Snakes, disturbed by the hurricane, had come up out of their profound hiding places; we found several of these remarkable amphibians and reptiles in shallow ditches by the roadside. After the hurricane, the weather didn't regain its former warmth; the land gradually cooled off,

and the Cottonmouths began to seek the higher ground.

In the big swamp, where the Wood Ducks nested in the Springtime and the large, old Gum Trees and Cypresses erected their massive trunks, the Cottonmouths began to leave their grass-covered logs where they had spent the Summer and to swim for shore. At the line of demarcation, where the low ground stopped, on which the water in places stood hip-deep, the high ground began; here were captured in no less than an hour's time, fifteen of these large, semi-aquatic reptiles. This was the only period of the year during which I observed any great amount of aggressiveness in these rather placid and lazy reptiles; in fact most of those individuals picked up at the time gave a good fight. On one such occasion, a large snake coiled under some fern leaves, lashed at me without provocation, and I stepped backward in the nick of time. By then, the water itself had considerably cooled off; I sighted a Cottonmouth on the surface, who, when chased, sought the banks where it tried to hide, rather than to plunge beneath the surface; this wasn't true of the water snakes, who seemed to be more tolerant of the drop in water temperature. So the Cottonmouths were migrating to higher ground, seeking suitable places to hibernate.

Most reptiles and amphibians that were scarce after the arrival of hot weather, now began to move about more freely; it is a well-known fact that cold-blooded animals, whose body temperatures vary with their surroundings, cannot stand extremes in heat or cold. In the midst of the Summer heat, most of them hide, going into a state of lethargy known as "Aestivation," a state similar to hibernation; Summer's lethargy is not so profound as Winter's, because in the Summer, rainy periods will bring them out.

Most reptiles were now on the move as they sought hiding places before the coming of Winter. One day, while strolling at the forest edge, I came upon a snake which might have been curious had it been watched by one uninitiated into some of the eccentricities of nature: at my approach, this snake began to flatten and to spread his body as wide as he could; he raised his head and began to flick his tongue and to viciously twist around like a cobra. The snake continued this most remarkable and unique performance by which, no doubt, he hoped to intimidate me. When I refused to give ground, this extraordinary snake suddenly changed his technique and now rolled on his back and lay motionless; he stuck out his tongue, feigning death. I walked over to the reptile and placed him on his belly, but he immediately rolled over on his back again; I several more times attempted this with the same end result, so intent was the snake upon faking death.

I had met for the first time the amazing Hog-Nosed Snake. The diet of this snake consists almost entirely of toads. The poison glands in the toad's skin have no effect on this particular snake. The Hog-Nosed Snake, in order to better swallow these toads, who puff up when attacked in order to keep from being swallowed, possesses two rear fangs to puncture the puffed up toad, another truly remarkable characteristic of this amazing reptile.

Leaves of the Red Maple and Sweet Gum trees turned crimson, and some of the oak leaves turned copper; outside of this, there was an absence of color. Reptiles were quite active, and there were reports from many places of the finding of at least one Canebrake Rattlesnake; this most quiet and elusive of all the rattlers seemed to be encountered most in the late Fall.

Birds were in migration: the first to depart was the Ruby-Throated Hummingbird; one Autumn night, these dainty and exquisite little birds set out across the Gulf of Mexico, heading straight for Yucatan and Central America, on an incredible, non-stop journey of not less than five hundred miles. Groups of Bank and Barn Swallows congregated on electric wires during the afternoon where they seemed to be holding a kind of conference in soft voices; then suddenly, they, too, were off! One evening, as I happened to be walking by the great marsh, I saw a large number of Tree Swallows flying in small groups of from fifteen-to-twenty each, very low to the ground, on their way to some exotic land; the early evening glow accentuated the metallic sheen of their plumage. One by one, these brave migrators of the avian world departed. Fall activities of the reptiles diminished.

In early evening, as one contemplated the varied forms of moss-laden Cypresses under the delicate rose-pink autumnal sky, one really knew that Winter was almost upon us, and that it would take yet another Springtime to restore the life cycles of this vast, unvanquished land, to restore that new, yet eternal, cycle which would begin with the blooming of the Bloodroot, the Yellow Adder's Tongue, the Carolina Jasmine and the Coral Honeysuckle.

Toward the end of October, cold winds began to blow in from the sea as the Indian Summer vanished. November came with its damp winds and cold rains. So the eternal forest was now still and without one voice, musing in its solitude.

"Oh silent forest, where are your Summer thrills, those calls of Hooded Warblers? Now that the warblers have all gone, you seem plunged into melancholia! It is, indeed, a contagious melancholia that penetrates my whole being until I become a part of this forest mood; it is a most restful mood; I would gladly give up everything just to feel this most wonderful Fall Melancholia, which moves me with each new breath of crisp, Autumn air, and just to watch a golden leaf twirling in the erratic breeze!"

Now the days grew noticeably shorter; darkness crept up much faster. Winter's cold weather had finally set in with a firm footing, and ducks were speeding on their journey from the North: in the early dusk, Pintails, Mallards, Redheads, Canvasbacks and Green-Winged Teals alighted in the marshes among the reeds. One could also see large flights of Canadian Geese who had returned to their favorite marshes; these familiar Canadian Geese who, although they had been gone so long, seemed actually a part of these same marshes; indeed, so much so that it was difficult now to visualize these marshes without them! I was happy to see again their "V" formations in the sky, for there is nothing quite like the rushing sound of hundreds of pairs of wings and the soft, nasal honks of a flock of wild geese in the twilight; it is true poetry and wild life artistry which I hope many will be able to enjoy for generations yet to come, for in so many places today, it has already become one of those aesthetic heritages of our natural world denied to thousands, a sad thing indeed.

The Snow Geese arrived later and I could once more see their large flocks circling and twirling around the marsh; nothing can be quite so spectacular as a flock of these great, white birds with black wing tips, as they soar about before alighting; as they passed through the light rays, their full colors came into play, just before they alighted with a majestic swoop. Thousands of these birds often alight over an open area where the reeds have been burnt off each year by the conservation department so they may obtain an easier subsistence from the plant roots.

But the most majestic bird to arrive from the North was the Whistling Swan; these usually arrived in smaller flocks than either the Canadian or Snow Geese. Swans are certainly among the most graceful of birds, and it was a great thrill to watch them with their long, thin necks and their upper wing feathers raised over their backs as a sail, riding as if asleep upon the dark blue water.

The small dove which I had rescued after it had fallen from its flimsy nest in early June, was still with us and was now almost a full-fledged member of the Department of Natural History at the Norfolk Museum, or so one would have thought as it sat there on the back of a chair near my desk, industriously preening its feathers. At first, it had been a small, clumsy ball, hardly feathered at all, with a big, soft bill which had to be fed various seeds from my own mouth to replace its mother's "Pigeon milk." It was a helpless, tiny bird, making a lot of peeping sounds; and it required much attention and cuddling: now, however, it had grown to be a pert and sassy bird, who was the very picture of elegance; this same bird, when a clumsy fledgling, couldn't get enough petting; now it wouldn't allow anyone to handle it because it couldn't stand to have its feathers disarranged! Even though it was aloof, it was still a most friendly and gentle bird; and I could never cease admiring this slender and lovely thing daintily picking seeds on the museum's patio. At the slightest rustling of leaves, or any other strange movement or noise, it would promptly fly into the air with whistling wings; and it would alight on my shoulder where it would grow calmer as it preened its feathers and pecked my ears.

During the second week in December, a new bird arrived in Tidewater, the Fulvous Tree Duck: this was the first time this species had been sighted so far North; they were first observed in the great marshes of Back Bay, near the North Carolina State Line, then at Knotts Island in small groups of from eight-to-fourteen individuals. One of the peculiarities of this particular duck was that it did much more gliding than the average duck; in flight, they somewhat reminded one of a hawk. All of these things add up to the one great advantage of being located in the Tidewater area, being so to speak, almost in the center of the great bird flyways; every Winter one sees birds entirely new to this area.

December moved in with a cold, North wind, and there were periods of much frost. Muskrats had a hard

time in the marshes, and so did the Nutria, that huge South American rodent, distant kin to the muskrat, an escapee from the fur farms, who has established himself quite well over most of Tidewater.

Hawks began to arrive from the North: Duck Hawks, Rough-Legged Hawks, Sharp-Shinned Hawks, and even a few Saw-Whets and Snowy Owls; the last two mentioned, though not regular visitors here, came as far as Southern Virginia when their food supply up North became scarce.

One day in mid-December, I experienced the thrill of seeing a Goshawk take off from the top of a dead Cedar Tree which it had selected as a lookout point near an open field so as to watch for its quarry. The Goshawk stayed for the best part of December, so I had an excellent opportunity to observe it several times. After this, I saw the remains of doves and quails almost every time I crossed this open field where the Goshawk had its lookout point.

The Cooper's Hawk, which is a smaller replica of the Goshawk, is a far more familiar sight in the Tidewater area; however, it is no-less fierce than its larger cousin. The Sharp-Shinned Hawk is also very similar to the other two hawks already mentioned; these three belong to a genus known as "*Accipiter*." They are all swift, savage, fearless and merciless and are great destroyers of other birds; this gives hawks in general a bad name, which is most unfortunate, since hawks generally are more beneficial than harmful.

During the long Winter months when reptiles and other fauna and flora are all asleep, I spend most of my time bird watching. Most hawks and owls hunt for rats and mice in the open fields bordering the big swamp; corn and other leftover crops in such fields form a good Winter reserve for these rodents which, in turn, form a basic supply of victims for the wintering hawks and owls.

Once, in late December, I had the opportunity to watch a Loggerhead Shrike in action: I was walking in an open field several hundred feet from the woods, along a barbed wire line bordered by a short pine thicket and some bushes, a very typical environmental set-up for a shrike. A glacial breeze was blowing from the North, when my attention was centered on a bird of familiar attitude; a quick look through my field glasses corroborated immediately my belief that it was a Loggerhead Shrike. I watched this bird for more than an hour as it went through certain typical movements: It would generally hold itself on the barbed wire in a horizontal position with an occasional up-and-down motion of its tail. The shrike kept its eyes constantly on the ground. The bird suddenly dived, then flew close to the ground for several seconds; it had spotted a Field Mouse. When its prey was reached, it extended its white-bordered tail and wings to their fullest spread, giving the bird a graceful appearance; then it ran along the ground, furiously pecking at its prey.

After having subdued the Field Mouse, the shrike ate the front half of the mouse and impaled the remainder of him on a spine. On another occasion, I saw this same bird repeat this performance; and after each evolution, the bird returned to its perch on the barbed wire. This shrike wasn't wild and seemed undisturbed by my presence; I was able to approach it rather closely several times. Because of certain rather typical habits, the shrike is easily recognized in the field.

By the end of December, heavy snows fell on the big swamp; it doesn't often snow in the mid-Atlantic swampland, but when it does, the snow falls in large flakes, and soon the whole land disappears under a great, white mantle. Generally, after a few days, a big thaw follows and everything underfoot becomes mire. During that year, however, there were unusual frosts, so the snow lasted for an unusually long period, more than two weeks, and the forest edge was like a row of skeletons on a white mantle piece; thus did the whole land sleep under such a mantle, totally unlike the semitropical area to which one had become so accustomed.

Through such northern blizzards, a long bird laboriously pushed southward from Alaska where its food supply had become exhausted; it was a sustained flight, with the bird stopping only for the necessary rest, then pushing onward again through blinding snowstorms, guided only by its own primitive instincts; all known landmarks had disappeared in those thick snowflakes. Then one day, after this long flight, there arrived in a large, open field at the edge of the Dismal Swamp of Southern Virginia, a bird of most noble appearance: black, with greenish-yellow legs and black claws; for the balance of the Winter, this bird soared and hunted in our open fields: it was a Harlan's Hawk, and it came all the way from Western Canada.

Once more I stood, as of old, at the edge of this great wilderness, looking at the dark tree line and the white snow; large snowflakes again began to fall rapidly, and to my left, I saw the prints of a wildcat forming black shadows on the soft, snowy carpet as they disappeared into the briers where the silent beast was now in hiding. I just stood there, not moving, feeling those soft flakes falling on my face; and I thought of these great swamps, my wilderness, fast disappearing before man's rapid advance. Yesterday

untouched, vast, virgin; today retreating more and more before the plow: already one glade, one canebrake, one brier patch have been each one eliminated by the plow. One timbered area fallen under the ax; one low, wet swamp drained by a canal; all such places, once good swampland, now numerous aquatic life breed there no more, where the Cottonmouths can no longer live; these beasts are today constantly retreating before a man-made drought that leaves them strangled.

Appendix.

Scientific names of fungi, plants, and animals mentioned in the text of Land Unvanquished, Parts IX-XVI

(compiled by Steve Roble, with assistance from Rob Simpson on Fungi)

Fungi

Death Angels	*Amanita virosa* (probably)
Lemon Yellow Amanita	*Amanita citrina* (probably)
Deadly Amanita	*Amanita brunnescens* (probably)
Death Trumpets	*Craterellus cornucopioides* (= *C. fallax*)
Oyster Mushroom	*Pleurotus ostreatus*
Hedgehog Hydnum	*Hericium erinaceus*

Plants

Yellow Adder's tongue	*Ophioglossum vulgatum*
Long-Leafed Pine	*Pinus palustris*
(Bald) Cypress	*Taxodium distichum*
"cedar grove" (presumably Atlantic White Cedar)	*Chamaecyparis thyoides*
Cedar Tree (= Eastern Red Cedar)	*Juniperus virginiana*
Cattail; reeds	*Typha angustifolia* and/or *Typha latifolia*
Cane (and canebrake)	*Arundinaria gigantea*
Foxtail	*Alopecurus carolinianus*
Spanish Moss	*Tillandsia usneoides*
Brier (= Greenbrier)	*Smilax* spp.
Vernal Iris	*Iris verna*
Wild Iris	*Iris virginica*
White Oak	*Quercus alba*
Mistletoe	*Phoradendron leucarpum*
Spatter dock	*Nuphar advena*
White (Water) Lily	*Nymphaea odorata*
Marsh Marigold	*Caltha palustris*
Sweet Bay Magnolia	*Magnolia virginiana*
Spice Bush	*Lindera benzoin*
Bloodroot	*Sanguinaria canadensis*
Great Trumpets; Trumpet Plant	*Sarracenia flava*
Pitcher Plant	*Sarracenia purpurea*
Sundew (with "paddle-shaped leaves")	*Drosera intermedia*
Venus Flytrap	*Dionaea muscipula*
Sweet Gum	*Liquidambar styraciflua*
Red Maple	*Acer rubrum*
Gums; Gum Tree	*Nyssa aquatica* and/or *Nyssa biflora*
Carolina Jasmine	*Gelsemium sempervirens*
Trumpet Vine	*Campsis radicans*
Coral Honeysuckle	*Lonicera sempervirens*

Invertebrates

Red Bug (= Chigger)	*Trombicula alfreddugesi*
Tree Cricket	*Oecanthus* sp.
Great Purple Hairstreak	*Atlides halesus*
Hummingbird Moth	*Hemaris thysbe*
Yellow Fly	*Diachlorus ferrugatus*
Wild Bee (= Honey Bee)	*Apis mellifera*

Fish

Mullet	*Mugil cephalus*

Amphibians

Amphiuma	*Amphiuma means*
Sirens	*Siren intermedia* and/or *Siren lacertina*
Oak Toad	*Bufo quercicus*
Little Grass Frog	*Pseudacris ocularis*
Barking Tree Frog	*Hyla gratiosa*
Bullfrog	*Rana catesbeiana*

Reptiles

Alligator	*Alligator mississippiensis*
Mud Turtle	*Kinosternon subrubrum*
Little Musk Turtle (= Stinkpot)	*Sternotherus odoratus*
Spotted Turtle	*Clemmys guttata*
Red-Bellied Turtle	*Pseudemys rubriventris*
Yellow-Bellied Turtle	*Trachemys scripta scripta*
(Snapping Turtle); "snapper"	*Chelydra serpentina*
Broad-Headed Skink	*Eumeces laticeps*
Six-lined Racerunner	*Aspidoscelis sexlineata*
Green Anolis	*Anolis carolinensis*
Mud Snake	*Farancia abacura*
Rainbow Snake	*Farancia erytrogramma*
Eastern King Snake	*Lampropeltis getula getula*
Scarlet King Snake	*Lampropeltis triangulum elapsoides*
Hog-Nosed Snake	*Heterodon platirhinos*
Corn Snake	*Elaphe guttata*
Black Rat Snake (= Eastern Ratsnake)	*Elaphe alleghaniensis*
Yellow Rat Snake	*Elaphe alleghaniensis*
Black Swamp Snake	*Seminatrix pygaea*
Southern Ring-necked Snake	*Diadophis punctatus punctatus*
Red-Bellied Snake	*Storeria occipitomaculata*
Worm Snake ("serpentine imitation of the earthworm")	*Carphophis amoenus*
Crowned Snake	*Tantilla coronata*
Rough Earth Snake	*Virginia striatula*
Scarlet Snake	*Cemophora coccinea*
Yellow-Lipped Snake	*Rhadinea flavilata*

Glossy Water (Crayfish) Snake	*Regina rigida*
Banded Water Snake	*Nerodia fasciata*
Brown Water Snake	*Nerodia taxispilota*
Red-Bellied Water Snake	*Nerodia erythrogaster*
Coachwhip	*Masticophis flagellum*
Coral Snake	*Micrurus fulvius*
Copperhead	*Agkistrodon contortrix*
Southern Copperhead	*Agkistrodon contortrix contortrix*
Eastern Cottonmouth	*Agkistrodon piscivorus piscivorus*
Cottonmouth Moccasin	*Agkistrodon piscivorus*
Pygmy Rattler; Pigmy Rattlesnake	*Sistrurus miliarius*
Banded Rattlesnake; Canebrake Rattlesnake	*Crotalus horridus*
Eastern Diamondback Rattlesnake; Diamond-Back Rattlesnake	*Crotalus adamanteus*

Birds

Bittern (=American Bittern)	*Botaurus lentiginosus*
Great Blue Heron	*Ardea herodias*
Snowy Egret	*Egretta thula*
Mallard	*Anas platyrhynchos*
Pintail	*Anas acuta*
Green-Winged Teal	*Anas crecca*
Wood Duck	*Aix sponsa*
Redhead	*Aythya americana*
Canvasback	*Aythya valisineria*
Fulvous Tree Duck	*Dendrocygna bicolor*
Snow Goose; "Snows"	*Chen caerulescens*
Canada/Canadian Goose	*Branta canadensis*
Whistling (= Tundra) Swan	*Cygnus columbianus*
Black Vulture	*Coragyps atratus*
Turkey Vulture	*Cathartes aura*
Duck Hawk (= Peregrine Falcon)	*Falco peregrinus*
Sharp-Shinned Hawk	*Accipiter striatus*
Cooper's Hawk	*Accipiter cooperii*
Goshawk	*Accipiter gentilis*
Red-Tailed Hawk	*Buteo jamaicensis*
Rough-Legged Hawk	*Buteo lagopus*
Harlan's Hawk	*Buteo jamaicensis harlani*
Marsh Hawk	*Circus cyaneus*
Sooty Tern	*Onychoprion fuscatus*
Great-Horned Owl	*Bubo virginianus*
Snowy Owl	*Bubo scandiacus*
Screech Owl	*Megascops asio*
Saw-Whets (= Saw-whet Owl)	*Aegolius acadicus*
Ivory Bill Woodpecker	*Campephilus principalis*
Pileated Woodpecker	*Dryocopus pileatus*
Downy Woodpecker	*Picoides pubescens*
Red-Crested (= Red-bellied) Woodpecker	*Melanerpes carolinus*
Kingfisher (= Belted Kingfisher)	*Megaceryle alcyon*
Ruby-Throat/Throated Hummingbird	*Archilochus colubris*
Chuck-Will's -Widow	*Caprimulgus carolinensis*
Yellow-Billed Cuckoo	*Coccyzus americanus*
Mourning Dove; "doves"	*Zenaida macroura*
Passenger Pigeon	*Ectopistes migratorius*
Carolina Parakeet	*Conuropsis carolinensis*
Quail (= Bobwhite)	*Colinus virginianus*
Barn Swallow	*Hirundo rustica*
Bank Swallow	*Riparia riparia*
Tree Swallow	*Tachycineta bicolor*
Tufted Titmouse	*Baeolophus bicolor*
Loggerhead Shrike	*Lanius ludovicianus*
Yellow-Breasted Chat; Night Bird; ("bird with the breast of flame")	*Icteria virens*
Hooded Warbler	*Wilsonia citrina*
Wilson's Warbler	*Wilsonia pusilla*
Painted Bunting	*Passerina ciris*
Indigo Bunting	*Passerina cyanea*

Mammals

Opossum; "possums"	*Didelphis virginiana*
Long-Tailed Shrew (= Southeastern Shrew)	*Sorex longirostris*
Evening Bat	*Nycticeius humeralis*
Hoary Bat	*Lasiurus cinereus*
Field Mouse (= Meadow Vole)	*Microtus pennsylvanicus*
(Southern) Flying Squirrel	*Glaucomys volans*
Muskrat	*Ondatra zibethicus*
Nutria	*Myocastor coypus*
Raccoon; "coons"	*Procyon lotor*
Otter	*Lontra canadensis*
Mink	*Neovison vison*
Bobcat; wildcat	*Lynx rufus*
Mountain Lion; panther	*Puma concolor*
Black Bear; bear	*Ursus americanus*
Wild Hog	*Sus scrofa*
White-Tail Deer	*Odocoileus virginianus*

Reports

1. Symposium in Honor of Richard Hoffman

The Virginia Natural History Society (VNHS) and the Virginia Museum of Natural History (VMNH) co-organized a special symposium that was held on 21-22 September 2007 at the museum's new facility in Martinsville to honor the career and 80th birthday of Dr. Richard L. Hoffman. Cosponsors of the event were Patrick Henry Community College and the Virginia Herpetological Society. Co-organizers of the event were Steve Roble and Joe Mitchell of VNHS (Co-editors of *Banisteria*) and Nick Fraser of VMNH (Director of Research and Collections).

Richard Hoffman is a native Virginian who has devoted a large portion of his life to the study and documentation of the natural history of Virginia and the southern Appalachians, while also earning an international reputation as the leading scholar of the world's milliped fauna. He was a cofounder of *Banisteria* (with Joe Mitchell) and the Virginia Natural History Society, serving for nearly a decade (1992-1999) as one of the original coeditors of the journal (and suggested its name). Richard is currently an Associate Editor of *Banisteria*, an Honorary Councilor of VNHS, and its only life member.

A three-hour social reception at the museum on Friday night kicked off the weekend's activities. Saturday's symposium, entitled "A Lifetime of Contributions to Myriapodology and the Natural History of Virginia: A Symposium in Honor of Richard L. Hoffman's 80th Birthday," was attended by more than 50 participants from 12 states and consisted of 19 scientific papers, as well as a talk by Dr. Hoffman on millipeds and myriapodologists.

The banquet on Saturday night took place in the new museum's central exhibit area, with more than 75 dinner guests in attendance. A total of 16 speakers made brief informal presentations of relevance to Richard, who received an assortment of gifts as well as a congratulatory proclamation from the Virginia state legislature. Approximately 90 people attended the reception, symposium, and/or banquet.

Group photo of Hoffman symposium attendees

Symposium Presentations

Steve Roble – "Richard Hoffman: A Biography and Review of his Contributions to Virginia's Natural History"

Joe Mitchell – "Richard Hoffman's Contributions to Herpetology"

Dick Highton – "The Discovery of *Plethodon hoffmani* and Why Richard Hoffman Became a Myriapodologist"

Bill Shear – "Richard Hoffman's Contributions to Myriapodology"

Janet Reid – "Copepod Crustacean Diversity in Virginia"

Wayne and Dianne Mathis – "Biodiversity of Shore Flies (Diptera: Ephydridae) from an Upper Coastal Plain Site in Virginia"

Kurt Buhlmann – "Life History of the Chicken Turtle, *Deirochelys reticularia*"

Jerry McDonald and Larry Freeman – "The Giant Pleistocene Beaver, *Castoroides,* in Virginia, with Emphasis on a Pathological Specimen from Saltville Locality SV-2"

Doug Ogle – "Land Surface and Weather: Interactions that Position Rare Communities"

Jerry Lewis – "Blame it on Richard: The Unholy Union of *Caecidotea* with *Pseudotremia*"

Rowland Shelley – "Way Down South: The Milliped Family Parajulidae (Julida) in Central America"

Petra Sierwald – "Planetary Biodiversity Inventory of the Class Diplopoda: Cataloging All the Species"

Kevin Pitz – "Insights into Relationships within the Order Spirobolida (Diplopoda: Helminthomorpha)"

Chris McAllister – "Distribution of the Milliped, *Aniulus garius* (Parajulidae): First Records for IN, MN, NY, SD, UT, VA, WI, and WY"

Bruce Snyder – "Interactions of Earthworms and Millipedes in the Great Smoky Mountains National Park: A Beginning in Diplopodology"

Paul Marek and Jason Bond – "A Molecular Phylogenetic Approach to Genus Delimitation within the Xystodesmid Tribe Apheloriini (Polydesmida)"

Jim Murray – "*Cepaea nemoralis* in Virginia: Some Answers, Many Questions"

Jim Arnold – "Considerations of *Calymmaria virginica* and *C. persica* in the Virginias (Araneae, Hahniidae)"

Lynn Ferguson – "Dr. Richard Hoffman - Biospeleologist: Apterygote Hexapods"

Richard Hoffman with gift from the Virginia Natural History Society

Banquet Speakers

Jim Beard – Master of Ceremonies

Lawrence Hoffman	Steve Roble
Carl Hoffman	Joe Mitchell
Rick Boland	Boris Kondratieff
Melody Cartwright	John Pagels
Trina Apple-Stevens	Ralph Eckerlin
Sonya Wolen	Doug Coleman
Bob Hogan	Nick Fraser
Judy Winston	Richard Hoffman

Jason Gibson, President of the Virginia Herpetological Society, presented a hand-carved walking stick to Richard Hoffman

Richard Hoffman addressing banquet guests

Additional photos of the symposium and banquet can be viewed on the society's website (va-nhs.org). In 2008, the Virginia Museum of Natural History will publish the proceedings of the symposium and other invited papers (approximately 35 total papers) as a contribution to its *Special Publications* series. We are currently reviewing and editing these manuscripts.

Steve Roble, Joe Mitchell, and Nick Fraser
Co-organizers and co-editors,
Richard Hoffman Honorary Symposium

Richard Hoffman with *Banisteria* Co-editors
Joe Mitchell and Steve Roble

2. President's Report

The society would like to extend a heartfelt thanks to Anne Lund who has been our Secretary/Treasurer since the birth of the Virginia Natural History Society in 1992. Anne has been a faithful and dedicated member of our society and her knowledge of the Society's history and how to get things done has been a real asset to the Virginia Natural History Society. Anne will soon be retiring from Hampden-Sydney College. I would like to welcome Bill Shear, Professor of Biology at Hampden-Sydney College, who will be replacing Anne as Secretary/Treasurer.

I would also like to thank Joe Mitchell for serving as Co-Editor since the origin of *Banisteria*. Joe has moved to Florida and will be reducing his role with the journal. Joe was one of the original founders of the Virginia Natural History Society and has contributed a tremendous amount of time in editing manuscripts and is one of our most frequent authors.

As reported in the proceeding pages, the Virginia Natural History Society co-organized a symposium that was held this fall in honor of Richard Hoffman, another of our original founders. This was the second successful symposium co-organized by our Society (see *Banisteria* 13 for details of the Big Levels Symposium).

The Virginia Natural History Society executive committee met on December 1, 2007. The committee has planned to have a symposium on the history of natural history in Virginia sometime in 2009. See the announcement in this issue for more details.

The committee also proposed a contest for a logo for the Virginia Natural History Society. The logo will be used in future publications, events, and possibly items for sale to give our society better recognition.

Our Webmaster, John White has installed a Google search engine on the *Banisteria* webpage. Visit our website and try it at: http://fwie.fw.vt.edu/vnhs/journal.htm. We plan to add more, and eventually all, of the *Banisteria* articles in pdf format.

We also discussed becoming more involved with the new Virginia Master Naturalist program by offering the expertise of our members.

If you have a new email address or need to update your address, please send me an email. The society is trying to update our email database so that we can communicate better with our members.

Consider submitting a manuscript to *Banisteria* for publication. There are no printing charges for members. Also, get one or more of your fellow naturalists to join the Virginia Natural History Society.

Tom McAvoy (tmcavoy@vt.edu)
President, Virginia Natural History Society

3. Minutes of December 2007 Council Meeting

Minutes of the Council Meeting – Virginia Natural History Society, Hampden-Sydney College, Gilmer Hall, Hampden-Sydney, Virginia, December 1, 2007, 1:05 to 3:00 PM

Council members in attendance: Art Evans, Richard Hoffman, Barry Knisley, Michael Kosztarab, Michael Lachance, Anne Lund, Tom McAvoy, and Steve Roble. Bill Shear was also present at the meeting.

Tom McAvoy, Society President, presided. He presented a brief report concerning our council membership and their terms in office. There was brief discussion of membership and funds over the past 15 years.

The Secretary/Treasurer reported a current membership of 133, 19 of which are institutions. As of October 31, 2007, the treasury contains $5,860.08. A membership list was circulated for council members to gather information and to correct any errors. It was suggested that a corrected list be sent to the Society council members electronically, and that efforts be made to develop a more complete list of member email addresses for possible future announcements, including reminders about membership renewals. Tom McAvoy will work on updating the email list for Virginia Natural History Society members.

Anne Lund will resign as Secretary/Treasurer at the end of this meeting, and Bill Shear was appointed Secretary/Treasurer by election of the council. He will serve the last year of Anne's current term and then, according to the by-laws of the Society, stand for election to a four-year term.

There was a discussion concerning editors for the journal *Banisteria* since Joe Mitchell now lives in Florida. It was agreed that Steve Roble would handle Editor responsibilities with the aid of Associate Editors (to include Joe starting in 2008) for the foreseeable future.

Concerning the journal, *Banisteria* #30 will soon be ready to send to the printer. It was brought to the attention of the group that the "Bioblitz 2006 at Potomac Gorge" report would be the second issue of 2008 and likely exceed 100 printed pages. The first issue of 2008 might be small relative to others that have been published. Help with publication and mailing of the Bioblitz 2006 results will come from The Nature Conservancy via a grant from the National Park Service. The Secretary/Treasurer will send an invoice to Mary Travaglini of TNC of MD/DC to receive the $2,000 that the group set aside for this publication.

Steve Roble was acknowledged for his work with the Hoffman Symposium. He thanked the Society for its generous financial contribution towards the expenses

for the symposium honoring Richard Hoffman's service to Virginia's natural history study for his 80 years. The proceedings of the symposium will be published as a book by the Virginia Museum of Natural History rather than as a special issue of *Banisteria.* A brief summary report about the symposium will appear in the next issue of *Banisteria*.

It was agreed that we would send out letters for renewal of membership for 2008. Included with the membership mailing would be an announcement concerning the planned symposium on the history of natural history studies in Virginia. It was agreed that the symposium would be at least 18 months in the future to accommodate proper planning and publicity and a call for papers. A committee of the council members will work on the planning of the symposium, including Tom McAvoy, Steve Roble, and Barry Knisley, and with help from Michael Kosztarab. It was suggested that Richard Hoffman explore the possibility of the Virginia Museum of Natural History being the site for the history symposium. Other ideas included thinking of Jefferson and Monticello as possible topics to explore and finding a science historian who might help design the symposium or serve as a keynote speaker.

The discussion of a logo for the Society resulted in a decision to post possible designs submitted by members (and non-members) on the website and then allow the membership to select its preferred logo. With a generous donation from Michael Kosztarab and matching funds from the Society, it was decided that $100 would be awarded for the winning logo.

The Society will make additional articles from past issues of *Banisteria* available on its website. Tom McAvoy agreed to work on numbers 1-5 and Michael Lachance will scan numbers 6-8, so far. Tom will investigate how best to do this scanning so that a searchable database will be achieved. Steve Roble will continue to work on preparing PDF files from existing electronic document files for *Banisteria* numbers 15-28.

There was discussion of the society becoming involved with the Virginia Master Naturalist program. Tom McAvoy and Michael Lachance will stay in contact with this program to see how we can become involved and to let students in the program know about the society. This may be a good source for new members.

The next Virginia Natural History Society council meeting will be on December 6, 2008.

The meeting was adjourned at 3:05 PM.

Respectfully submitted,
Anne Lund, Secretary/Treasurer

4. Secretary/Treasurer's Report

The Society has a current membership of 133, 19 of which are institutions. As of October 31, 2007, the treasury contains $5,860.08.

This is my last report for inclusion in *Banisteria*. I have served as Secretary/Treasurer since 1992, and I have certainly enjoyed my experiences with the Virginia Natural History Society through the council meetings and at the business meetings after the Biodiversity Section papers have been presented at Virginia Academy of Science yearly meetings. The new Secretary/Treasurer is Dr. William (Bill) Shear. Bill is a colleague at Hampden-Sydney College and will continue the "office work" for the Society from here at the College. I wish the Society continued success in all aspects of its mission.

As always, we encourage our present and active members to recruit members for the Society. A membership form is included with this mailing. Please pass it on to a friend or colleague interested in the natural history of our state. This is really important.

We continue to be grateful to Hampden-Sydney College for support with the paperwork/computer work concerning our treasury, membership records, and mailings. Effective immediately, please submit all enquiries about membership in the Society or about past issues of *Banisteria* to: Dr. William Shear, Virginia Natural History Society, Box 96, Hampden-Sydney, Virginia 23943, or email, wshear@hsc.edu.

Respectfully submitted,
Anne Lund, Secretary/Treasurer

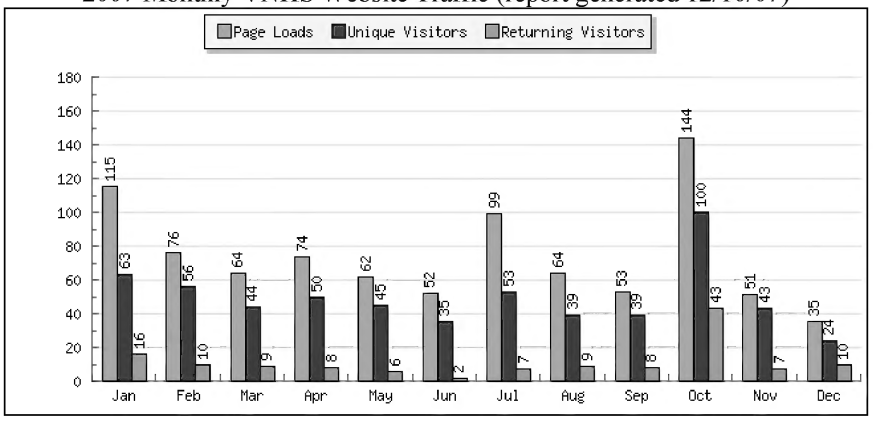
5. Webmaster's Report

Five additional articles in PDF format were added from past issues of *Banisteria*. The Dr. Richard L. Hoffman 80th Birthday/Symposium page has been added. A VNHS website search function is now operational and can be found at the following URL: http://fwie.fw.vt.edu/vnhs/journal.htm

The location of recent visitors to the VNHS website is summarized below:

Number	State/Country	Number	State/Country
26	Virginia	2	Ireland (Dublin)
14	Unknown	2	Connecticut
12	New York	2	Austria (Vienna)
5	India (Delhi)	1	West Virginia
5	California	1	Idaho
4	Maryland	1	Massachusetts
4	Florida	1	Indiana
3	Alabama	1	District of Columbia

2007 Monthly VNHS Website Traffic (report generated 12/10/07)



The above graph is a monthly summary of VNHS website visitation during 2007. The website currently consists of 347 files and requires approximately 12.1 MB of server storage space. We would like to thank the Conservation Management Institute (www.cmiweb.org) for hosting our website.

Respectfully submitted,
John White, VNHS Webmaster

6. Co-editors' Report

This is another special edition of *Banisteria* for several reasons. It covers a broad sweep of natural history in Virginia from exotic plants and reptiles to beetles and other invertebrates to birds and mammals. This is truly the kind of coverage of natural history that we had envisioned. It again highlights a renaissance naturalist, Roger de Rageot, who was an educational icon in the Virginia Beach area for many years; we include here the second half of his lengthy essay on the Great Dismal Swamp and vicinity. Finally, this issue of *Banisteria*, Number 30, marks the final issue co-edited by Joe Mitchell, who founded this journal along with Richard Hoffman in 1992. Joe will take on an Associate Editor role beginning in 2008.

As we always do here, we are seeking manuscripts, large and small, on Virginia's natural history. Since its inception, the pages of *Banisteria* have been filled with a broad range of articles and contributions to Virginia's natural history, as again exemplified in this current issue. We very much appreciate the efforts of all authors, reviewers, and Associate Editors in helping to make *Banisteria* a success. Please join the distinguished list of authors who have published in these pages and make your own contribution.

We thank the following individuals for reviewing manuscripts during the past three years: Paul Bedell, Allen Belden, Art Bogan, Jason Bond, Mark Branham, Alvin Braswell, Kurt Buhlmann, Mitchell Byrd, Ron Caldwell, Fred Coyle, Dave Culver, Ken Dodd, Mike Donahue, Mike Dorcas, Carl Ernst, Terry Erwin, Art Evans, Gary Fleming, Ollie Flint, Henri Goulet, Alan Griffith, William Grogan, Jr., Carola Haas, Phil Harpootlian, Richard Hoffman, John Holsinger, John Jensen, David Johnston, Barry Knisley, Paul Lago, Carolyn Mahan, Bill McAvoy, Mike Mengak, Joe Mitchell, Jane O'Donnell, Karen Patterson, Harry Pavulaan, Tim Pearce, Mike Pogue, Steve Roble, Bob Rose, Paul Sattler, Al Savitzky, Nathan Schiff, Toby Schuh, Terry Schiefer, Dale Schweitzer, Bill Shear, Bruce Sorrie, Charlie Staines, Warren Steiner, Don Thomas, Mike Thomas, Susan Walls, Bryan Watts, Bryan Wender, Al Wheeler, Tom Wieboldt, and Bill Williams. We apologize if we have inadvertently omitted any peer reviewer's name from this list.

We would like to remind our readers that the table of contents for each issue of *Banisteria* can be viewed on the society's website at va-nhs.org. We have prepared PDF versions of many of the published articles and shorter contributions for posting on the website. We will eventually post all published articles more than a year old, but this will take some time. John White, our Webmaster, has recently added a Google custom search engine that allows one to search posted *Banisteria* papers by topic, key word, species, author, or just about any word. A printable order form for back issues, as well as a membership application form, is also available on the website.

We hope to finally return to a regular spring and fall publishing schedule starting next year. We already have several manuscripts and notes for the next issue of *Banisteria*, but need a few more. The June 2006 Potomac Gorge Bioblitz report is expected to comprise a large second issue of *Banisteria* in 2008.

Respectfully submitted,
Joe Mitchell and Steve Roble, Co-editors

Announcements

1. Change in Editorship of *Banisteria*

Steve Roble, Co-editor of *Banisteria*, will become Editor in 2008. Joe Mitchell, Co-founder of *Banisteria* and Co-editor for the first 30 issues (16 years) of the journal, has recently relocated to Gainesville, Florida. He will continue to review manuscripts periodically in his new role as an Associate Editor.

2. Prize Contest to Design Logo for VNHS

The Virginia Natural History Society extends an invitation to all interested parties to submit design(s) for consideration for a logo for the society. This is an open competition with a **cash prize of $100** for the winning entry. The successful logo may be featured in VNHS material including, but not limited to, the society's website, software media, apparel, and business systems.

The competition will close on April 1, 2008. The words "Virginia Natural History Society" or the initials "VNHS" must appear in the logo. The winning artist must agree to transfer ownership and copyright of the logo to the Virginia Natural History Society. The complete rules of the competition, submission details, and the design brief are posted on the society's website at va-nhs.org. Please forward all designs and contact details via email to: vhs.webmaster@verizon.net.

3. History of Virginia Natural History Symposium

The Executive Council of the Virginia Natural History Society is beginning to plan for a proposed 1-2 day symposium in 2009 concerning the history of natural history in Virginia, particularly the period spanning the past 400 years. We invite inquiries from potential speakers, attendees, or cosponsors, including other regional or local societies and organizations. Speakers could potentially discuss the **history** of a subdiscipline of natural history (e.g., botany, mycology, archaeology, paleontology, entomology, ichthyology, herpetology, ornithology, mammalogy, marine biology, geology, biospeleology, parasitology, natural history illustration, conservation, etc.) **in Virginia,** or present biographical information about a naturalist from the past. Topics of interest could include the earliest known surveys, collections or published reports in their discipline, the rate of knowledge accumulation, key historical figures, most significant discoveries, changes in the fauna/flora during the past 400 years, current status of knowledge, etc. Manuscripts from presenters will be published in a special issue of *Banisteria*, or possibly a book. Interested parties should contact VNHS President Tom McAvoy (tmcavoy@vt.edu) or Vice President Barry Knisley (bknisley@rmc.edu) to discuss their desired level of participation or offer relevant suggestions.

4. Lifetime Achievement Award

At its fall meeting at Virginia Commonwealth University on October 20, 2007, the Virginia Herpetological Society (VHS) awarded *Banisteria* Co-editor Joe Mitchell with a Lifetime Achievement Award for outstanding contributions to the field of herpetology in the Commonwealth of Virginia. The VHS has presented this award, its highest honor, only twice previously in its 49-year history (Frank Tobey, 1998; Richard Hoffman, 1999). Congratulations Joe.

5. Major Mammal and Flea Collections Donated to Virginia Museum of Natural History

The Virginia Museum of Natural History (VMNH) now holds the largest collection of Virginia mammal specimens thanks to the recent donation of more than 16,000 specimens from Virginia Commonwealth University. The collection, about two-thirds of which consists of rodents, includes 50 of the 73 species of land mammals native to Virginia. The VCU Mammal Collection was established in 1969 and curated since then by Dr. John F. Pagels, Professor of Biology, who is a VMNH research associate and long-time member of the Virginia Natural History Society.

Another VMNH research associate and long-time VNHS member, Dr. Ralph P. Eckerlin, Professor of Biology at Northern Virginia Community College, Annandale, recently donated more than 1,000 prepared slides of identified fleas to VMNH. This collection greatly enhances the reference value of the museum's entomological holdings, which were previously very deficient in terms of these ectoparasitic insects.

6. Second Appalachian Karst Symposium

East Tennessee State University (Johnson City, TN) will host a symposium May 7-10, 2008 to foster communications and to promote the exchange of ideas among all professionals concerned with scientific studies and environmental conservation in the Appalachian karst region. The organizing committee is soliciting oral presentations and posters of recent studies related to conservation, biodiversity, hydrology, geomorphology, and exploration of Appalachian karst. The proceedings will be published as a special issue of the *Journal of Cave and Karst Studies*. For more details visit: http://www.etsu.edu/physics/appkarst/.

Virginia Natural History Society
Website: va-nhs.org

General Information

The Virginia Natural History Society (VNHS) was formed in 1992 to bring together persons interested in the natural history of the Commonwealth of Virginia. The VNHS defines natural history in a broad sense, from the study of plants, animals, and other organisms to the geology and ecology of the state, to the natural history of the native people who inhabit it. The goals of the VNHS are to promote research on the natural history of Virginia, educate the citizens of the Commonwealth on natural history topics, and to encourage the conservation of natural resources. Dissemination of natural history information occurs through publication of the journal *Banisteria*, named for John Banister (1650-1692) who was the first university-trained naturalist to work in Virginia. The first issue was published in 1992, and the journal is published twice per year in spring and fall. Articles cover a wide array of subjects, and prospective authors are encouraged to submit manuscripts on any aspect of natural history in Virginia; book reviews and biographies of relevance to natural history in Virginia are also welcomed. The editor of *Banisteria* will also consider manuscripts on any aspect of natural history from neighboring states if the information concerns a species native to Virginia or the topic is directly related to regional archaeology, anthropology, botany, ecology, zoology, paleontology, geology, geography, or climatology. Manuscripts are peer-reviewed for suitability and edited for inclusion in the journal. Page charges ($15/page) are waived for VNHS members. The society's website contains instructions for authors, the titles (and abstracts beginning in 2004) of all *Banisteria* papers, and downloadable versions (PDF format) of numerous articles from past years.

Memberships

The VNHS is open to anyone with an interest in natural history and welcomes participation by all members in society activities and efforts to promote education and conservation. Membership includes a subscription to *Banisteria* and invitations to periodic symposia and BioBlitz surveys. Annual dues for members are $20 (per calendar year); library subscriptions are $40 per year. Checks should be sent to the Secretary/Treasurer, who also has back issues of *Banisteria* available at $10.00 each (except Nos. 1-6 are $5.00 and No. 13 is $18.00). The VNHS is a tax-exempt, nonprofit, society under Section 501(C)3 of the IRS. We welcome donations to support our mission in Virginia.

The Virginia Natural History Society
Application for Membership

Name _____

Address _____

_____

_____

Zip Code _____

Phone _____

Email _____

Area(s) of Interest _____

ANNUAL DUES AND SUBSCRIPTIONS TO *BANISTERIA*

(memberships and subscriptions are by calendar year; subscribers/members outside the United States should add $3.00 for additional postage)

- ☐ $500.00 Life (not annual)
- ☐ $300.00 Benefactor
- ☐ $100.00 Patron
- ☐ $50.00 Supporting
- ☐ $40.00 Institutional
- ☐ $25.00 Family
- ☐ $20.00 Regular
- ☐ $5.00 Student (see below)

☐ I have added a contribution of $_____ to my membership dues.

The special student rate is applicable only when accompanied by the following certification signed by a faculty advisor.

Institution _____

Advisor _____

Date _____

Make checks or money orders payable to:
Virginia Natural History Society

Send membership form and dues to:
Dr. William Shear, Secretary-Treasurer
Virginia Natural History Society
Box 96
Hampden-Sydney, Virginia 23943